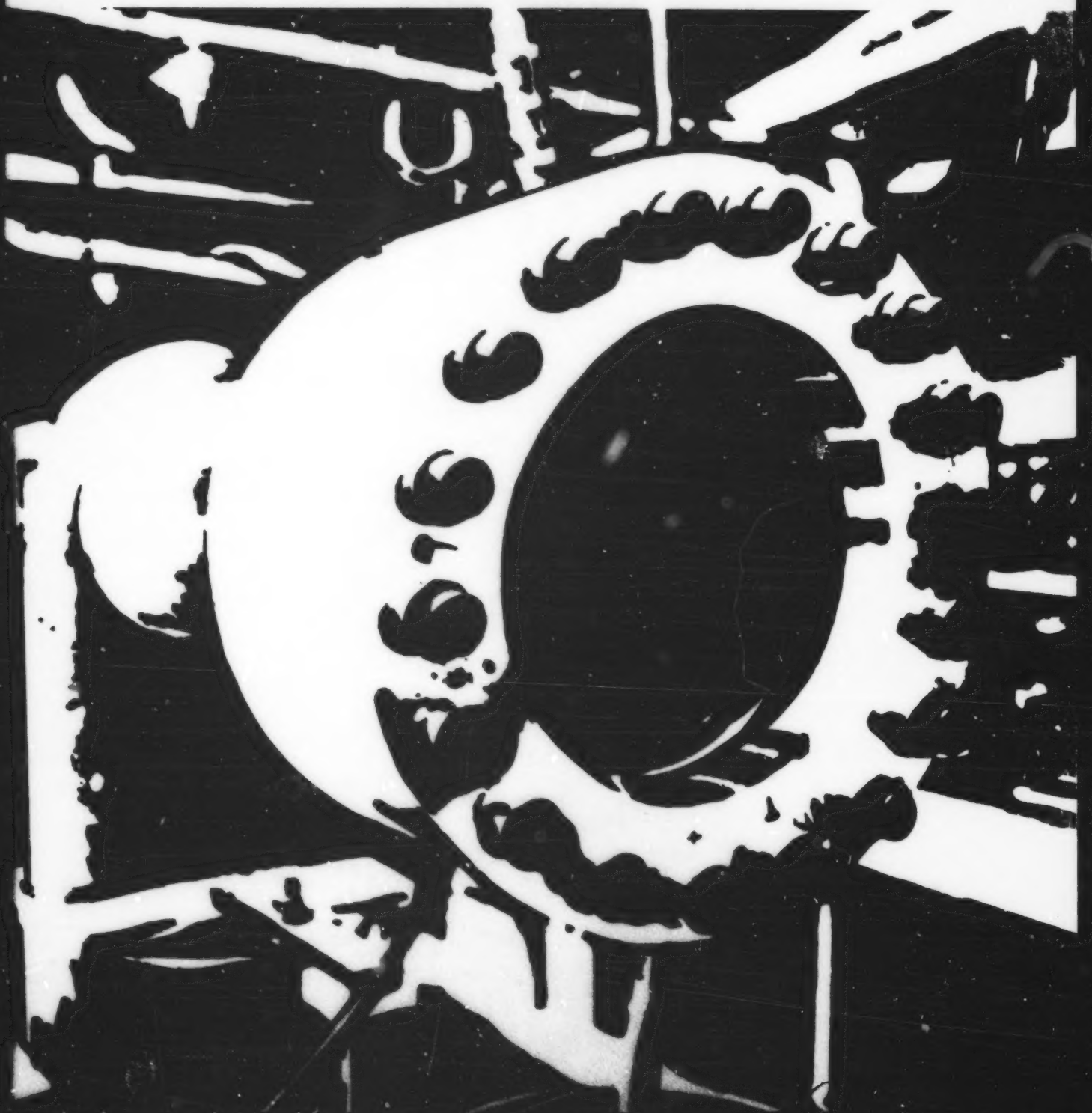
# ALBERTA/CANADA ENERGY RESOURCES RESEARCH FUND

PROGRAM SUMMARY
AND
EIGHTH ANNUAL REPORT



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**TO:**

The Honorable John Zaozirny
Minister of Energy and Natural Resources
Edmonton

The Honorable Patricia Carney
Minister of Energy, Mines and Resources
Ottawa

Honorable Ministers:

We have the honor to present the Program Summary and Highlights from 1976 to March 1984 and Eighth Annual Report for the fiscal year ending March 31, 1984 relating to the **Alberta/Canada Energy Resources Research Fund Agreement.**

Respectfully submitted,

Dr. K. Whitham
Co-Chairman, Alberta/Canada
Energy Resources Research Fund

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# INTRODUCTION



The Alberta/Canada Energy Resources Research Fund (A/CERRF) was created as a result of the March 1974 agreement between the producing provinces and the Government of Canada to hold the wellhead price of domestic crude oil at $6.50 per barrel from April 1, 1974 to June 30, 1975.

In recognition of Alberta's agreeing to sell its crude oil below international prices, the federal government committed itself to provide increased funds to assist in strengthening and diversifying the Alberta economy. Of $144 million committed by the federal government, $96 million was directed at energy-related research projects.

Starting with the first project proposals in 1976, the fund's purpose has been twofold: to promote and support the development and efficient use of Alberta's existing and potential energy resources to meet the province's and Canada's medium- and longer-term energy needs; and to encourage the development of scientific and technical expertise in energy research, development and demonstration in Alberta.

Program guidelines used to assess project proposals include the following:

1. The A/CERRF program includes research, development and demonstration on both renewable and non-renewable (fossil fuel) resources, generally excluding oil sands and heavy crude oil. Alberta government funding of research into the development and utilization of these important resources is carried out through a Crown agency, the Alberta Oil Sands Technology and Research Authority (AOSTRA).
2. Eligible research, development and demonstration projects relate to exploration, production, transportation, conservation and utilization of Alberta's energy resources. Current areas of importance are research, development and demonstrations related to coal, and energy conservation and renewable energy.
3. Preference is given to applied or mission-oriented research projects, although some consideration will be given to funding of appropriate basic research projects.
4. As much as possible, preference will be given to projects using scientific and engineering expertise in Alberta.
5. The private sector in Alberta is encouraged to participate directly in the program through submission of appropriate research, development and demonstration proposals and through representation on specific project management and technical advisory committees.
6. Approved projects are carried out under a legal agreement between Alberta Energy and Natural Resources and the project participants, specifying the terms and conditions under which the research funds will be spent and the technology disclosed, owned and licensed.

The Alberta/Canada Energy Resources Research Fund Committee, made up of senior Alberta and federal government officials, has the responsibility of applying and administering the fund. The committee selects the projects to make up the program each year, and reviews their progress. The membership of the committee since 1976 is listed in Appendix A.

The A/CERRF program priorities were originally identified in the areas of:

**Conventional Energy Resources**, including enhanced oil recovery, advanced computer modelling, helium recovery from natural gas, natural gas properties and others;

**Coal**, including coal mining, beneficiation and coal conversion to gaseous and liquid products; and

**Energy Conservation and Renewable Energy**, with emphasis on energy conservation in buildings and in gas processing, and on solar and wind energy.

Since its implementation in 1976, the program has been refined and developed, under the management of the Alberta/Canada Energy Resources Research Fund Committee. Most projects in the area of **Conventional Energy Resources Research** have been completed, and construction is close to completion for the last **Research Buildings** project, the Devon Coal Research Centre. Subsequently, the energy research priorities have shifted to **Coal Research** and **Energy Conservation and Renewable Energy Research, Development and Demonstration** to reflect current energy concerns and the advancing state of technology.

To date, 75 projects have received A/CERRF support, 46 of which have now been completed. The research, development and demonstration projects fall into four categories:

13 projects and programs in the area of **Coal Research**;

46 projects related to **Energy Conservation and Renewable Energy**;

14 projects and programs in the area of **Conventional Energy Resources Research**; and

2 **Research Buildings** projects providing research facilities in Calgary and Devon.

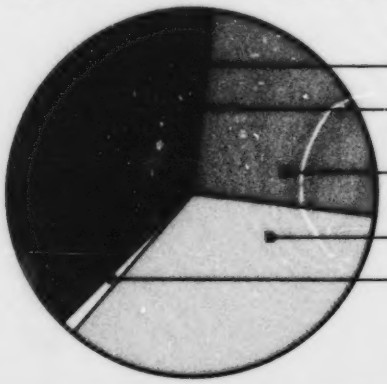
The research topics have been diverse, and have generated useful information or provided valuable contributions to the development of natural and human resources in the Alberta energy field.

Approximately $60.5 million have been spent of the available total program funds of $96 million. The funding distribution among the four project categories is shown in Figure 1. Excluding the expenditures for construction of the two research facilities, the Energy Resources Research Building, Calgary and the Devon Coal Research Centre, Figure 2 illustrates the funding pattern from the beginning of the program to fiscal year 1983/84 for the three major research, development and demonstration categories, Coal, Energy Conservation and Renewable Energy, and Conventional Energy Resources.

This funding pattern is consistent with overall program development, showing large expenditures for Conventional Energy Resources Projects during the first four to five years. As contributions declined for this category, expenditures increased for Coal Projects and research in this area has become a priority of the program. The Energy Conservation and Renewable Energy Projects category has maintained its funding share of approximately $1 million per year, and is the second priority of the A/CERRF program.

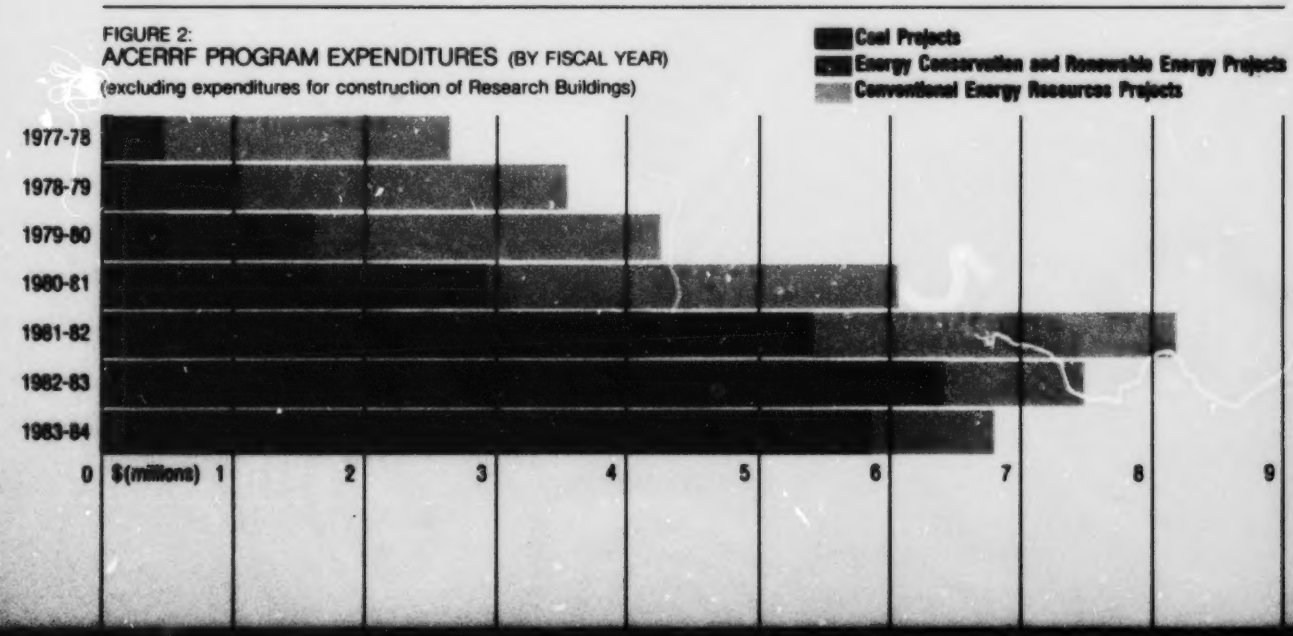
This report highlights a number of projects undertaken during earlier years as well as providing a review of projects active in the 1983/84 fiscal year. Detailed information on either current or completed projects is available from the Scientific and Engineering Services Division of Alberta Energy and Natural Resources.

FIGURE 1:
A/CERRF PROGRAM FUNDING DISTRIBUTION (1976 TO MARCH 31, 1984)



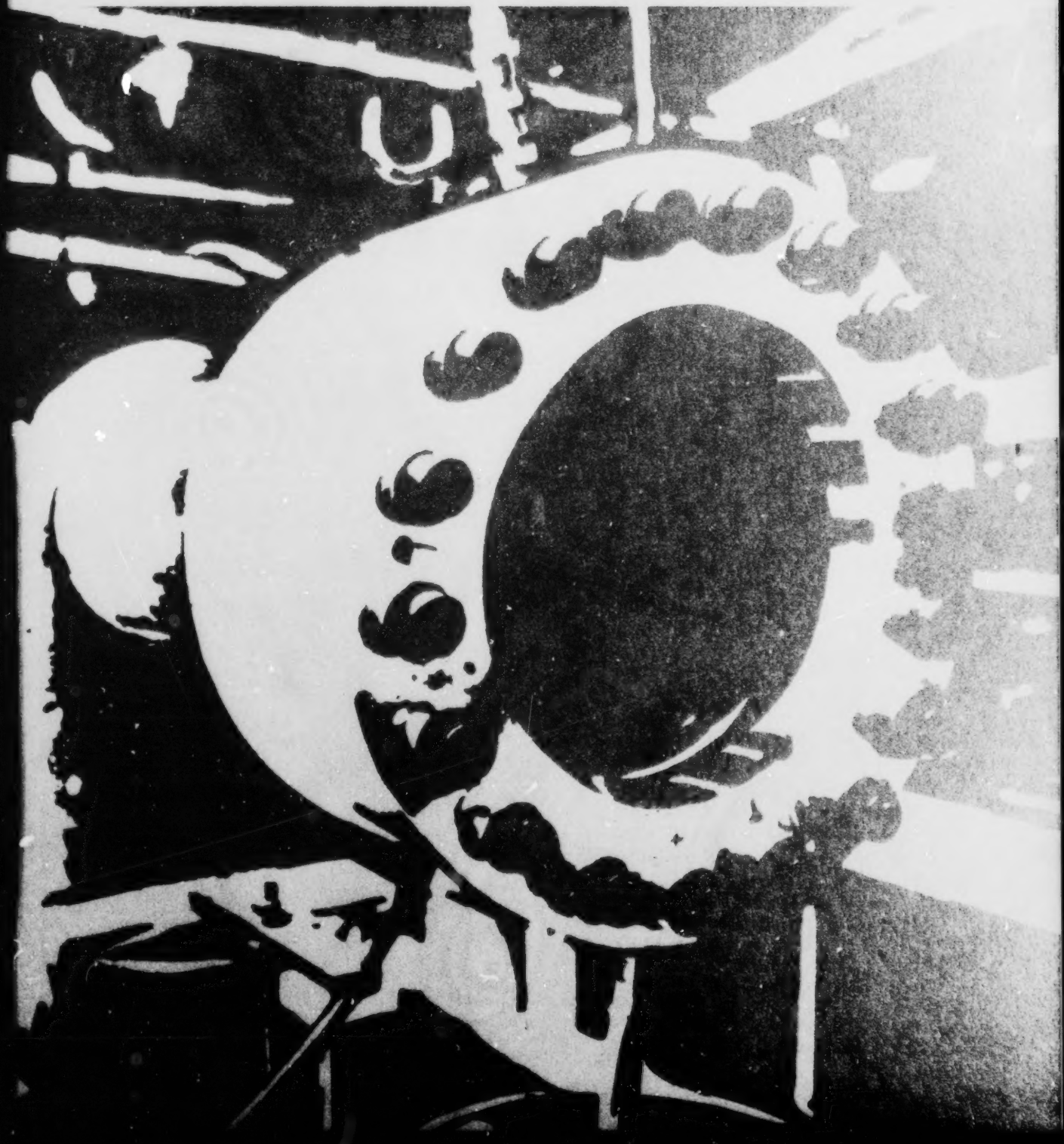
| | Funding ($) | Percentage (%) |
|---|---|---|
| Coal Research | 17,294,063 | 28.6 |
| Energy Conservation and Renewable Energy Research | 6,410,528 | 10.6 |
| Conventional Energy Resources Research | 15,296,747 | 25.3 |
| Research Buildings | 20,725,330 | 34.3 |
| Administration | 818,309 | 1.3 |
| TOTAL | 60,544,977 | 100.0 |

FIGURE 2:
A/CERRF PROGRAM EXPENDITURES (BY FISCAL YEAR)
(excluding expenditures for construction of Research Buildings)



1976 TO MARCH 31, 1984

# PROGRAM SUMMARY AND HIGHLIGHTS



# COAL PROJECTS

Coal is one of Alberta's most abundant resources. In the early 1970s, the focus for coal development was on opening new mines to meet the forecasted rapid growth in international coal demand and examining the possibility of converting coal into a synthetic crude oil to meet projected oil shortages. Consequently, the priorities for coal research and development in Alberta included conversion of subbituminous coal to liquid and gaseous fuels and establishing a capability in applied coal research for coal mining and cleaning. As a result of the A/CERRF support, a strong coal research and development capability has been established within the province.

Since 1982, the international coal market has become highly competitive, creating the need to revise these coal research and development priorities. Early in 1984, the Alberta Office of Coal Research and Technology was established within Alberta Energy and Natural Resources to encourage and promote research, development and application of new coal-related technology. The Alberta Office of Coal Research and Technology works closely with the Alberta coal industry to identify technical opportunities likely to have an impact on coal development in Alberta during the next five to 10 years.

An Alberta Coal Research Strategic Plan was prepared in November, 1983 to guide future research and development efforts. Projects selected for A/CERRF support must meet the goals of the plan which strives to develop technologies to:

a) enhance the competitiveness of Alberta coals in international markets;

b) minimize the environmental impact of the production or utilization of coal in Alberta; or

c) develop new uses for Alberta coals.

Emphasis will continue to be given to projects which demonstrate the commercial potential to:

a) improve the quality and minimize the cost of Alberta coals for the export market;

b) improve the cleaning of thermal coal and reduce the environmental impact of coal production in the province;

c) develop new uses for Alberta coals, including industrial applications and coal liquefaction; and

d) reduce the environmental emissions associated with combustion of subbituminous coal.

Brief descriptions follow of several coal projects carried out under the A/CERRF program.

## Reflection Seismic Investigation of Western Canadian Coal Fields

University of Calgary (D.L. Lawton), Calgary

In the past, most exploration of coal seams in Alberta was by drilling. This is a costly process, and can lead to uncertainties about the nature of the seams between drilling sites. This project examined an alternative approach for delineating underground coal seams in Alberta, using a refinement of the seismic reflection techniques used by the petroleum industry. An advantage of seismic methods is that they effectively test the continuity of coal seams since measurements can be taken at intervals as close as 2.5 to 5 metres.

Funded by A/CERRF from 1981 to 1983, the objective of the research was to test a method using a heavy industrial shotgun as the source of energy, instead of the more usual and more expensive use of dynamite, with a series of small receivers collecting echo signals from underground layers. The seismic information was corroborated by existing drilling data. In the field trials, the method performed best in the plains region and was less effective in the mountains, where complex faults in the underlying rocks made it difficult to get meaningful results.

Industrial shotgun used in seismic field tests

The seismic method, using the heavy industrial shotgun, was found to be most effective at depths between 60 and 200 metres. The Coal Mining Research Centre at Devon is refining the technique for use at shallower depths.

There has been considerable commercial interest in the test results. One company has used a modification of the method for a seismic survey in Nova Scotia, with very satisfactory results.

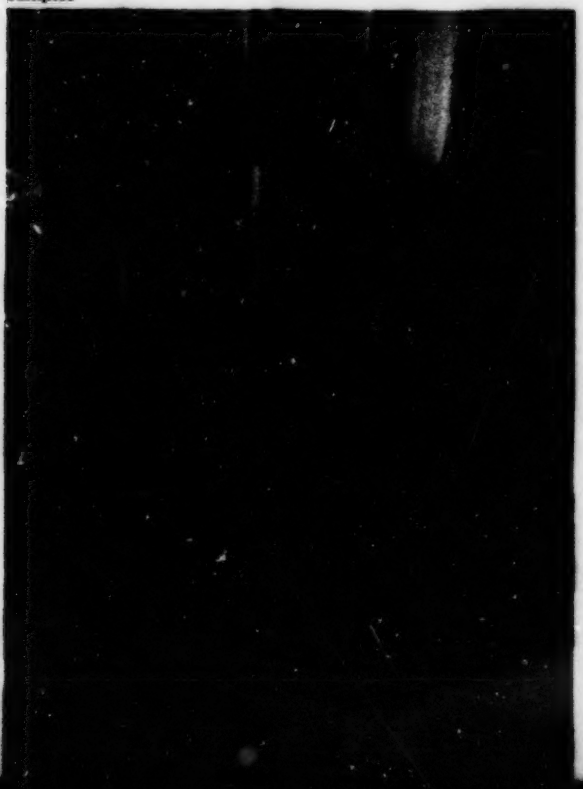
## Support Design for Underground Cavities in Weak Rock

University of Alberta (P.K. Kaiser, N.R. Morgenstern), Edmonton

Unlike metallic ore deposits, coal is often associated with weak rock formations. This lack of strength in the surrounding rock creates challenges for the design of underground mines. While the need for safety is paramount, the mine engineer must design the least expensive support system to prevent collapse of mine tunnels and work places.

The failure mechanism of the rock and coal surrounding these openings is complex. When combined with the local geological variation, it becomes extremely difficult to design a support system based on analytical methods. Consequently, most support systems are designed on the basis of experience and detailed observations in the mine.

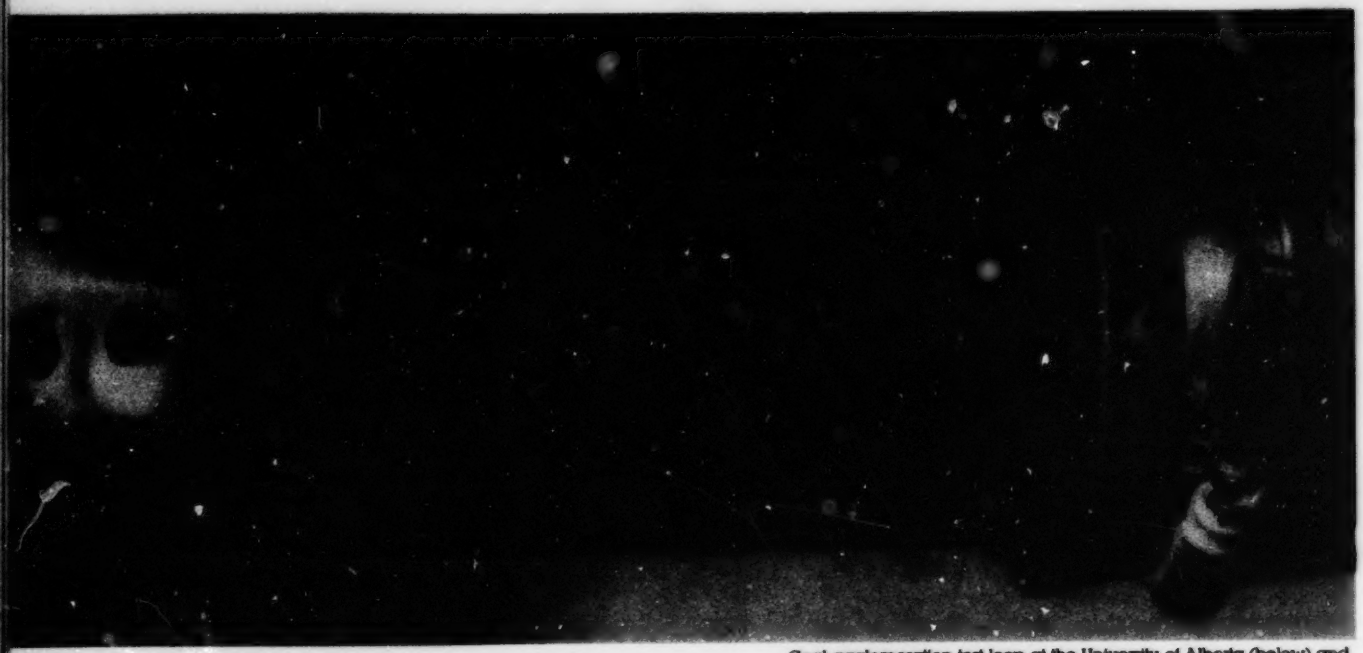
Experimental set-up for simulating the stress/creep behavior of rock samples



Rock sample with opening after stress/creep simulation test

This three year study was directed toward developing a more rational approach to the design of underground support systems. Cylindrical cavities were drilled into blocks of coal to simulate underground openings. Pressure was applied to these blocks in a special laboratory test rig. Changes in the size and shape of the cavities and surrounding coal were measured. It was found that the size of the cavities changed with time and pressure and that the rate at which these changes occurred could be related to the likelihood of failure of the specimen.

The results suggest that the rate of change in tunnel dimensions following excavation should be monitored and can be used to assist the design of appropriate supporting structures.



Coal agglomeration test loop at the University of Alberta (below) and coal agglomerates (above)

## Beneficiation of Alberta Coals by Agglomeration in Pipelines

University of Alberta (C.M. Rodkiewicz, M.L. Jeremic), and Alberta Research Council, Edmonton

Extensive work carried out by the National Research Council in Ottawa since the early 1960s demonstrated that certain coals can be separated from impurities and moisture by agglomerating fine coal particles using oil in a water emulsion.

In the agglomeration process, pulverized coal is blended with an oil/water emulsion. The oil in the emulsion adheres to the coal in preference to the undesirable clay and mineral matter particles. Once the coal particles are coated with oil, they are attracted together to form stable groups, or agglomerates, held together by the oil coating. The impurities remain dispersed in the water. The coal agglomerates can be readily separated from the impurities by filtration. The coal quality is higher, not only because of the lower impurity and moisture content but also because of the entrapped oil.

This process has been known to work best for high rank coals. The potential for adapting the agglomeration process for a variety of Alberta coals was examined jointly by the University of Alberta and the Alberta Research Council from 1980 to 1983. The feasibility of achieving beneficiation of the coals

using the agglomeration process while transporting the coal in a pipeline was an important aspect of the study.

Within the scope of this project, a series of bitumen and heavy oil samples were used as binders with both raw metallurgical coal and wash plant rejects. Both impurity and moisture contents were reduced to the range of commercial specifications, using either stirred tank or pipeline reactors. Subsequent work with bituminous and subbituminous thermal coals has demonstrated the feasibility of achieving a high quality thermal coal from both these sources using low quality bitumen, heavy oil/water emulsion and refining residuals.

U.S. and Canadian patent applications have been filed for the use of the agglomeration process for low rank subbituminous coals with bitumen or heavy oil.

Several companies have expressed interest in the application of this process for markets in both central Canada and in Pacific Rim countries. The technical challenge of this process is to reduce the net cost of the oil used for the agglomeration process.

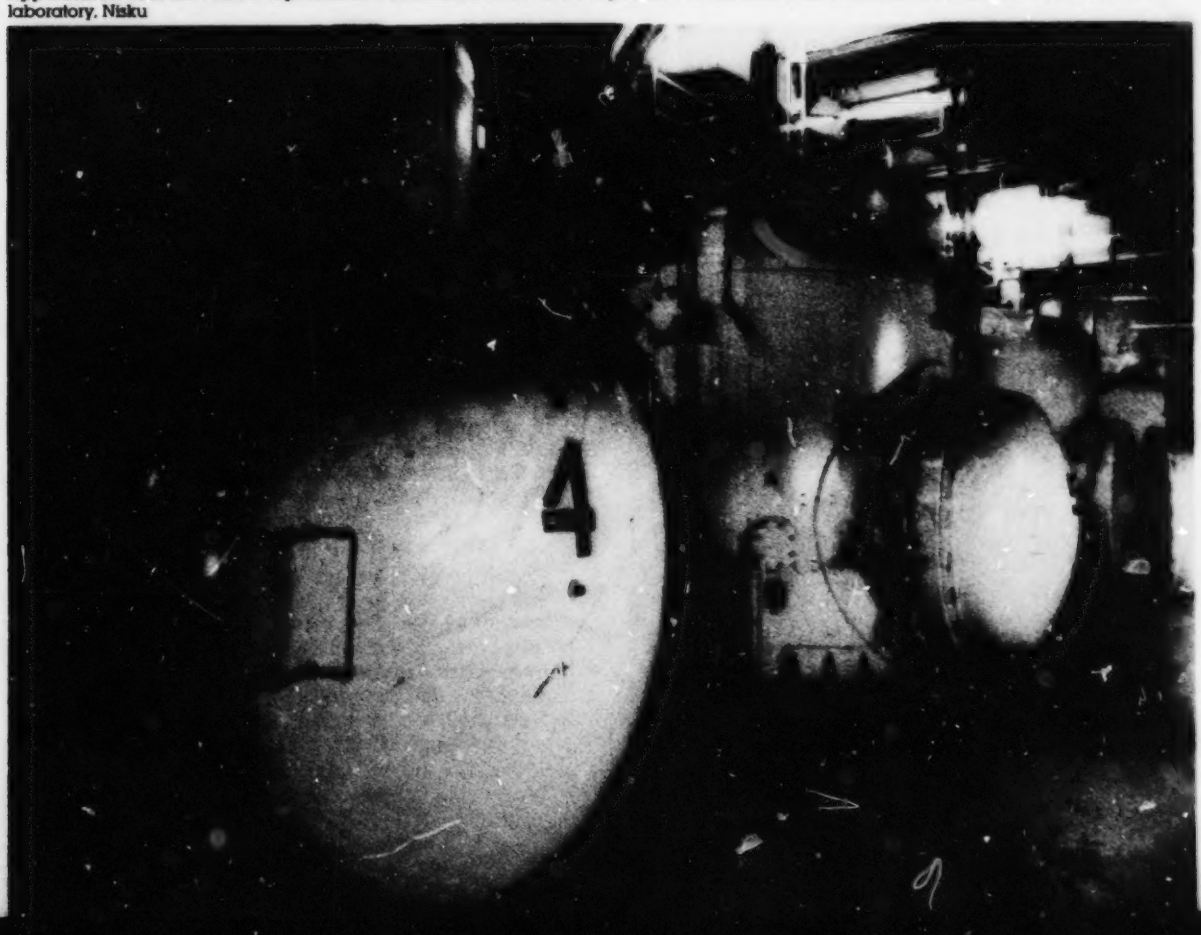
## EMR-ARC Coal Conversion Research Program

Alberta Research Council, Edmonton

This major program, of both national and international importance, is directed toward developing detailed knowledge about the potential to convert Alberta's significant deposits of subbituminous coals into liquid fuels and chemical feedstocks as an alternative to conventional crude oil. The program was initiated with partial A/CERRF funding in 1980 following discussions between representatives of industry, research organizations, universities and governments interested in coal development.

The Alberta Research Council has established a world class capability for studying direct coal liquefaction, co-processing of coal and heavy oil and pyrolysis techniques. Facilities include autoclaves of different volumes for batch experiments and continuous bench scale reactors capable of processing coal at feed rates up to several kilograms per hour. An extensive array of analytical facilities

Apparatus for coal conversion experiments is assembled inside these explosion containment cells at the Alberta Research Council's interim laboratory, Nisku



permit the characterization of feed coals and derived products.

While coal conversion to liquid products has been known since the 1920s and utilized during the Second World War in Germany to produce aircraft fuel, the economics of the early processes are not compatible with today's energy prices. New processes for coal conversion are being developed throughout the world, particularly in the U.S., West Germany, the United Kingdom, Australia and Japan. The suitability of these new processes for use with Alberta subbituminous coals is being evaluated by this program. The detailed examination of a process particularly suited to Alberta's oil sands, natural gas and low rank coal resources is included. The various processes show significant differences in coal reactivity and liquid product quality. The difference in reactivity among the different coals is less than expected and correlates with the two major subbituminous coal seams in the province.

Efforts are becoming focused on establishing co-operative programs with Canadian coal producers and with international research groups.

### Coal Slurry Pipeline Research

Pembina Resources Ltd., Calgary

Transportation costs are a major factor determining the potential market for Alberta coals. While the railroad has been the traditional means of coal transportation in western Canada, there has been increasing interest in using pipelines as an alternative. Several commercial coal slurry pipelines are in operation throughout the world. The economic potential for transporting coal from Alberta to Pacific tidewaters had been previously examined and found to be marginal.

This project, jointly funded by Pembina Resources Ltd. and A/CERRF, is examining the technical parameters which affect the pumping and pipelining characteristics of several different types of coal-water slurries and the effect of these on the economics of coal transportation. The major parameters which are being examined include the particle size distribution and the concentration of coal in the slurry.

Test work is being carried out by Pembina Resources Ltd. and the Saskatchewan and Alberta Research Councils in a collaborative effort.

It is expected that this study will result in a better understanding of the factors affecting the potential use of pipelines for transport of coal, not only over long distances but also within coal production operations.

### Analysis of Coal Bearing Strata Near Cadomin

University of Alberta (H.A.K. Charlesworth), Edmonton

### Coal Mining, Beneficiation and Health and Safety Research

Coal Mining Research Centre, Devon

### Stability in Underground Coal Pillars

University of Alberta (D.M. Cruden), Edmonton

### Coal Ash Monitoring System

University of Alberta (L.R. Plitt), Edmonton

### Agglomeration of Low Rank Alberta Thermal Coals

Alberta Research Council, Edmonton

### Coal Liquefaction Study

Algas Resources Ltd., Calgary

### Production of Activated Carbon

University of Calgary (E.L. Tollefson), Calgary

### Coal Technology Information Centre

Alberta Research Council, Edmonton

# ENERGY CONSERVATION AND RENEWABLE ENERGY PROJECTS



For the foreseeable future, our society will continue to rely on non-renewable conventional energy resources. Despite this generally accepted fact, the A/CERRF program continues to recognize the need for research and the development of new technologies in the areas of energy conservation and renewable energy.

Early program activities concentrated mainly on fundamental research. Topics included conservation of non-renewable energy sources in the industrial/commercial and residential sectors, and research, development and demonstration programs in the areas of solar, wind, geothermal and laser fusion energy sources.

Technical feasibility and resource assessment studies in these areas have been completed successfully, with considerable potential identified in some cases and economic constraints recognized in others.

More recently the emphasis has been on the practical demonstration of new energy conservation and alternative energy technologies. Major examples include the demonstration of potential energy savings for industrial and residential buildings and the development of wind energy turbines for direct water pumping.

Several representative projects, the results of which have already become successful commercially or show strong potential, are highlighted in this section.

Work will continue at the current level to support energy conservation and renewable energy research, and consideration is being given to the development and demonstration of cost-effective waste heat recovery techniques.

## Ice Nucleation Technique for Defouling Heat Exchangers

University of Calgary (J.W. Costerton), Calgary

Heat exchangers are used in many industries to cool industrial process water. Excess heat from the hot process water is transferred to the cooling water through large metal plates or multiple tubes in these heat exchangers. The surface of the metal plates or tubes, which separate the two water streams, is often increasingly coated by a jelly-like layer of bacteria normally present in the cooling water stream.

This biofilm acts as an insulator, creating a costly problem for industry, reducing the efficiency of the heat exchange process and forcing the shutdown of the plant at intervals for mechanical scrubbing. In nature, the similar biofilm often formed on rocks in a stream is removed when ice crystals form, lifting the film from the surface so it can be washed away. The researchers have developed a technique which mimics this process to clear heat exchanger surfaces without plant shutdown. An antifreeze mixture, cooled to -12°C is passed through the heat exchanger, clearing the surfaces. During 1983/84, modifications to the technique were made in preparation for a full-scale commercial trial.

A patent, entitled Biofilm Removal, has been issued by the U.S. and Canadian patent offices (U.S. Patent Number 4 419 248; Canadian Patent Number 1 161 833).

Bacterial colonization of metal on heat exchange surface

## Energy Conservation in Sour Gas Processing

Bow Valley Research Ltd, Calgary

In sour gas processing plants, energy is consumed to remove sulphur and other contaminants thus providing a suitable fuel for heating purposes and feedstock for industrial use. In earlier phases of this project, the potential energy savings within the industry were found to be equal to the combined natural gas needs of the cities of Red Deer, Medicine Hat and Grande Prairie. As well as quantifying potential savings, the researchers have developed the engineering knowledge and data to enable them to tackle specific problems within different areas.

As part of this work, a technique was developed for the energy efficient incineration of gaseous impurities from natural gas streams. While this technique is still at the commercialization stage for the sour gas industry, the research led to the successful development of small incinerators for commercial flares based on the same principle. These incinerators, which have been marketed successfully for three years, provide environmentally acceptable incineration of highly poisonous hydrogen sulphide and other potentially noxious gases.

Work continues on the development of a strategy for conducting detailed energy audits of sour gas processing plants. Measuring equipment was used in a number of plants to assess areas of major energy consumption. This data has been analysed in an effort to show where energy savings are possible, and where such savings are both cost effective and compatible with the efficient operation of the plant. The objective is to develop audit strategies which could be adapted for any of the province's natural gas processing plants regardless of size.

This firm has also become a world leader in Claus Process technology, based on about 17 years of experience with this sulphur-removal technology. A monograph developed several years ago led to a series of seminars on the Claus Process which Bow Valley Research Ltd. has given to industry representatives in Canada, the U.S. and as far afield as Singapore and Amsterdam. The seminars have become an important part of the marketing arm of the company.

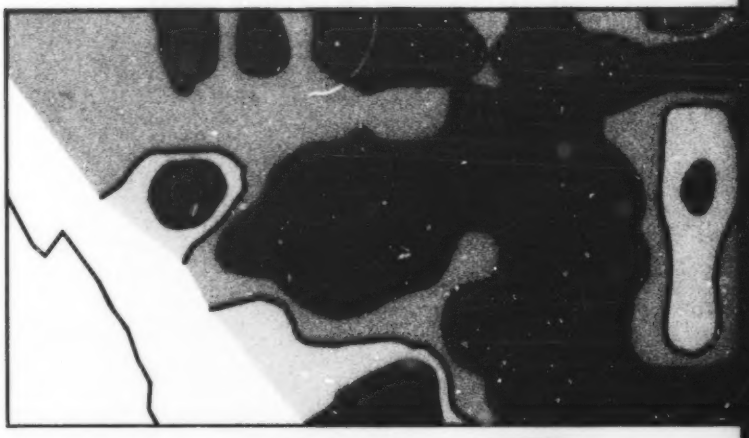
Sulphur plant aerial west of Cochrane, Alberta

## Research on Alberta's Geothermal Energy Resource

University of Alberta (F.W. Jones), Edmonton

Groundwater and rocks beneath the earth's surface store heat, and can be a potential source of energy. This project made use of data accumulated during oil and gas exploration to prepare a comprehensive analysis of the geothermal resources of Alberta. The first three years of the study were devoted to detailed mapping, recording temperature gradients (the rate at which the ground temperature changes with depth below the surface) and creating temperature contour maps.

Of particular interest were areas where groundwater relatively close to the surface was much hotter than expected. One of these, in the Hinton/Edson area, was the focus of detailed study in 1981/82, with potential uses identified in 1982/83. Geothermal energy is typically used in a closed system. Hot groundwater is pumped to the surface from a recovery well and its heat transferred to clean water which is circulated for space heating or other uses. The now cooler groundwater is pumped back into the ground in a rejection well. The Town of Edson is studying the feasibility of tapping the resource to heat a number of municipal facilities, including schools and a recreation complex.




Map of Hinton/Edson area showing promising geothermal temperature gradients

## Laser Fusion Energy Research

University of Alberta (A.A. Offenberger), Edmonton

There are many reasons for the attractiveness of nuclear fusion as an energy source. Once it becomes available technically, its fuel will be unlimited and its radioactivity hazards will be substantially lower than those of nuclear fission energy.

Increasingly, nuclear fusion has become a multi-billion-dollar focus of worldwide energy research, particularly in countries without a large resource of indigenous fuels. Most of this research has been concentrated on magnetic confinement techniques, in which a magnetic field is used to confine a hot plasma of ionized particles.

The researchers have been developing a short wavelength laser which can be used as an alternative technique promising a number of advantages over the more complex and difficult to maintain magnetic confinement approach.

With this technique, high-powered laser beams are used to compress and heat the surface of a fuel pellet to trigger a fusion reaction which takes place within a large vessel. A lithium blanket surrounding it absorbs

Krypton Fluoride Laser Target Facility at the University of Alberta

Front-end of University of Alberta Krypton Fluoride Laser Facility

energy which is then converted to conventional steam-generated electricity.

This laser approach is being moved several steps closer to reality with significant new developments undertaken at the University of Alberta. The four-year project, supported by A/CERRF, was completed early in 1984.

The project has refined a Krypton Fluoride (KrF) laser system considerably, and became one of the most sophisticated systems of this kind in the world. It has the potential to be scaled to very high energies at short wavelengths to make the most productive use of laser energy for target pellet compression and heating.

In addition to fusion research, laser technology has a number of promising applications in science and industry, and a joint university/private sector firm is being established in Edmonton to develop commercial applications of this technology.

Because of its short wavelength, the KrF laser is an appropriate source for laser platemaking and other lithographic applications which will probably include the fabrication of high-resolution microelectronic circuits (micro chips). The laser energy can also be converted readily to X-rays for use in medicine, testing and even finer-scale lithography.

Another spinoff of the original A/CERRF-sponsored research is in precision optics, an area in which Canada has had a weak infrastructure. Through links with private industry, the researchers are helping to build a comprehensive optics company which should be able to supply optical components and imaging systems to an international market.

## Alberta Home Heating Research Facility

University of Alberta (J.D. Dale), Edmonton

Six small buildings are the focus of important research in energy conservation for residential buildings. They are unoccupied, scaled-down replicas of single-family homes of approximately the size of a large-double garage with a conventional concrete basement. Each incorporates different energy conservation features such as insulation and window placement, ranging from pre-1970 standards to state-of-the-art superinsulation. The buildings are located at the University of Alberta Farm at Ellerslie.

The project was supported by A/CERRF for four years ending in 1983. Some of the research on the energy consumption in these homes have direct application for the consumer, while other work is more relevant to builders and equipment suppliers. In addition, computer modelling techniques have been refined.

A primary goal was the quantifying of energy losses and gains to be expected from each of the component features. The results provide an estimate of where the greatest energy and financial savings could be made. Such factors as air infiltration, sheltering, window placement and door type were considered along with the more obvious caulking and insulation.

Related research is continuing at the site, with support from A/CERRF, the National Science and Engineering Research Council and the University of Alberta. Among the projects are evaluations of the seasonal performance of masonry and conventional construction, and of high-efficiency furnaces under varying residential conditions.

This project has attracted national attention for its valuable contribution to the field of energy conservation in buildings.

Construction of roof overhang and track mechanism for the exterior shutters of passive housing module

Top section of wind turbine tower with rotor of prototype delta-blade wind turbine

## A Large Delta-Blade Wind Turbine, An Alberta Development

Abax Energy Services Ltd./Deltx Windpump Corporation, Calgary

Harnessing wind energy is not a new idea, but the state-of-the-art delta-blade turbines developed by a Calgary firm are a long way from the picturesque Dutch windmills.

The new direct water pumping wind turbines, developed by Abax Energy Services Ltd. of Calgary, are based on a design by University of Calgary professor Dr. J.A.C. Kentfield. An aerodynamically-efficient rotor is coupled mechanically to a piston pump for a variety of direct water-pumping uses.

A/CERRF has been involved in this on-going project since 1981, providing funds to assist in the refining of the design and the building of a prototype (described as the world's largest) capable of pumping about 1.5 cubic metres of water per second at a wind speed of 48 kilometres per hour. The low-cost, high-efficiency turbine has a 16-metre diameter rotor on a 31.4-metre tower. Monitoring of the system's actual performance over an extended time is continuing.

The delta turbine system appears to offer simplicity, cost effectiveness, efficiency and reliability for irrigation, hydropower generation, municipal water supply and other applications. The project is now at the stage of commercialization of the technology and has attracted a great deal of attention from potential Canadian and international buyers. Patent applications are being pursued with U.S., Canadian and Australian patent offices.

Two turbines have been ordered for the creation of a marsh habitat for waterfowl near Brooks.

Deltx Windpump Corporation, which is marketing the technology, is investigating a proposal to install 10 or more of the turbines at a hydroelectric dam, as a pilot project. The turbines would be used to pump water from below the dam to the upper storage reservoir, enhancing the dam's electrical output at times of low water flow.

Market indications project that Deltx Windpump Corporation will provide 300 to 400 manufacturing jobs by the end of 1985.

## Demonstration and Testing of Small-Scale Wind Turbines

Alberta Agriculture, Lethbridge

When Alberta Agriculture officials in Lethbridge were faced with the problem of finding a way to pump water out of sloughs and other low-lying areas, the older farmers in the district suggested using small wind turbines for driving water pumps.

Test site of small-scale wind turbines at Lethbridge

# OTHER ENERGY CONSERVATION AND RENEWABLE ENERGY RESEARCH PROJECTS SUPPORTED BY A/CERRF



Excess groundwater containing dissolved salts causes problems when the water cannot drain naturally. Electric pumps are used normally to pump the water from low-lying areas to surface drains. In many locations which require drainage to prepare the land for agricultural use, the nearest power line is so far away that the cost of getting the power exceeds the benefit of the drainage project.

Conversations with first generation farmers who recalled when windmill-driven water pumps were common in southern Alberta prompted Drainage Branch officials to investigate some of the newer wind power technology. It was found that very little was known about how the newer turbines would perform under Alberta conditions. A thorough test of the available technology was needed.

With funding from A/CERRF, Farming of the Future and Alberta Agriculture, a site adjacent to a St. Mary River Irrigation District canal just north of the Agriculture Centre in Lethbridge was chosen and prepared for the installation and demonstration of up to seven small wind turbines suitable for drainage pumping.

Since August 1983 six different turbines have been installed by participating turbine manufacturers or distributors. They are being tested and evaluated regarding their practical application and cost-effectiveness.

There has been a great deal of interest in this project with requests for information received from individuals and agencies in Alberta, other parts of North America and Europe. Manufacturers of wind turbines have expressed an interest in using the site to test their products, while farmers and irrigation districts are interested in purchasing proven units.

**Control of Energy Losses by Microbial Fouling of Heat Exchangers**
University of Calgary (J.W. Costerton), Calgary

**Using Thermal Discharges from Power Plants**
University of Alberta (A.H. Laycock), Edmonton

**Fuel and Fertilizer Production from Dairy Manure**
University of Alberta (J.B. McQuitty), Edmonton

**Efficient Use of Low Heating Value Fuels**
University of Calgary (G.A. Karim), Calgary

**Streamline Device for Transport Trucks**
Nahanni Industries, Winterburn

**Energy from Waste Wood (Sawmill Residue)**
B.H. Levelton and Associates Ltd., Vancouver

**Efficiency of Rotary Piston Engine**
Canadian Electrocar Ltd., Edmonton

**District Heating Study**
City of Edmonton, Edmonton

**Copper-Oxide Solar Cells**
University of Alberta (F.L. Weichman), Edmonton

**An Atlas of Solar Energy for Alberta**
University of Calgary (L.C. Nkemdirim), Calgary

**Application for Boiling and Condensation Heat Transfer for Flat Solar Collectors in Cold Regions**
University of Alberta (K.C. Cheng), Edmonton

**An Air-Mediated Solar Heating System with Long Term Storage**
University of Alberta (A.M. Robinson), Edmonton

**An Advanced Control Approach for Solar Heating Systems**
University of Alberta (R.E. Rink), Edmonton

**Insulation Properties of Flat Built-Up Roofs**
Alberta Roofing Contractors Association Ltd., Calgary

**Energy Efficient Housing Display Program**
HUDAC Alberta Council, Edmonton

**Passive Solar-Heated Community Centre**
Sunergy Systems Ltd., Carstairs

**Energy Efficient Masonry Fireplaces**
Centre for Research and Development in Masonry, Calgary

**Construction and Testing of a Masonry Module**
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**Energy Conservation in Public Swimming Pools**
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**Demonstration of a Cost-Effective Energy Management System**
Whitaco Holdings Ltd., Edmonton

**Development of a User Friendly Computerized Building Management System**
MLW Interspace Management Ltd., Edmonton

**A New Heat-Conserving Control System for Warehouse-Type Buildings**
Camcon Controls Ltd., Calgary

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**Self-Help Retrofit Manual for Owners of Multi-Family Housing Units**
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**Development of Higher Efficiency Gas-Fired Furnaces**
Flame-Master, Division of Bow Valley Industries, Edmonton

**Multi-Zone Setback Thermostat**
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J.E. Sworder Engineering Ltd., Edmonton

**Energy Savings and Payback of Retrofit Basement Wall Insulation**
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**Townhouse Retrofit Demonstration**
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Bill Johnston Architect Ltd., Calgary

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Sunergy Systems Ltd., Carstairs

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Comtrac Industries Ltd., Calgary

**Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology**
EMC Energy Management Consultants Ltd., Calgary

**Concrete Masonry Walls for Thermal Storage, Heating and Insulation**
Centre for Research and Development in Masonry, Calgary

**Solar and Wind Energy Research**
Alberta Research Council, Edmonton

**Comparison Study of Wind Turbines**
Dalcor Group, Edmonton

# CONVENTIONAL ENERGY RESOURCES PROJECTS



In the area of Conventional Energy Resources, research and development includes work on natural gas, conventional oil and exploration and recovery technologies, using experimental as well as analytical approaches.

The A/CERRF-supported research has been directed at getting the best value from these non-renewable resources and at recovery techniques, which will help give Alberta's industry a competitive edge in the international marketplace.

Emphasis has been given to applied research and development with potential short-term application in Alberta's resource industry or other relevant areas of the private or public sector. Most of the projects in this category have been completed, and considerable success has been achieved.

## Software for Computer-Assisted Petroleum Exploration

Computer Modelling Group, Calgary

With the newest developments in computer modelling, petroleum engineers have a tool to test recovery alternatives and accurately simulate results before making costly forays into the field.

Until recently, most reservoir simulation software was imported and was not ideally suited to Canadian conditions. Now, however, an Alberta company at the forefront of the technology is meeting Alberta needs as well as exporting it worldwide.

The Computer Modelling Group (CMG) of Calgary was established in 1977 with funding from A/CERRF. Over the seven years of its agreement with A/CERRF it has become self-supporting, providing service to its membership as well as marketing its programs widely. Its membership is drawn from the energy industries of six countries and also includes a number of Canadian research agencies.

The reservoir simulation models developed by CMG are both primary recovery and enhanced recovery techniques, including water and chemical flooding, steam injection and in situ combustion techniques. CMG has also succeeded in refining their analytical programs.

Part of CMG's function is to offer courses to its membership, providing an opportunity for petroleum engineers to become familiar with reservoir simulation technology.

Computer Centre of Computer Modelling Group, Energy Resources Research Building, Calgary

## Helium Recovery From Natural Gas

Alberta Helium Ltd, Calgary

Helium, the second lightest chemical element, is an inert gas which has several commercial uses including arc welding, fill gas for lighter than air blimps and balloons, and the protection of integrated circuit microelectronic chips. Helium is found in natural gas reserves but at concentrations too low to allow economic recovery using conventional separation technologies. Consequently, no attempt was made in Alberta to separate and capture this resource.

In the early 1970s, the Alberta Research Council investigated the use of semi-permeable membranes for separation of helium from natural gas at concentrations typical of those found in Alberta. Alberta Helium Ltd. was established to pursue the commercial development of the technology.

The company, with A/CERRF funding support from 1977 through 1982, designed, built and operated a pilot plant to establish the large-scale feasibility and economics of the unique process.

The feasibility of the technology was demonstrated, but because of current world market conditions, it was found to be uneconomic in the short term. However, very promising commercial possibilities were identified in related work separating hydrogen, carbon dioxide and hydrogen sulphide from both natural gas and industrial gas mixtures.

The technology is particularly promising in the area of sour gas processing. Using this approach, the bulk of acidic gases can be removed at a much lower energy cost than that of conventional processes. The membrane process can be used as a preliminary step, so that the more costly conventional processes need to be used only to remove the small quantities of acidic gases remaining.

Work to date suggests that attractive savings could be realized by retrofitting existing plants, particularly where feed gases contain a high concentration of hydrogen sulphide.

Gas cleaning facilities for helium products

Pressure vessel containing a commercial-sized hollow fibre membrane module for helium recovery

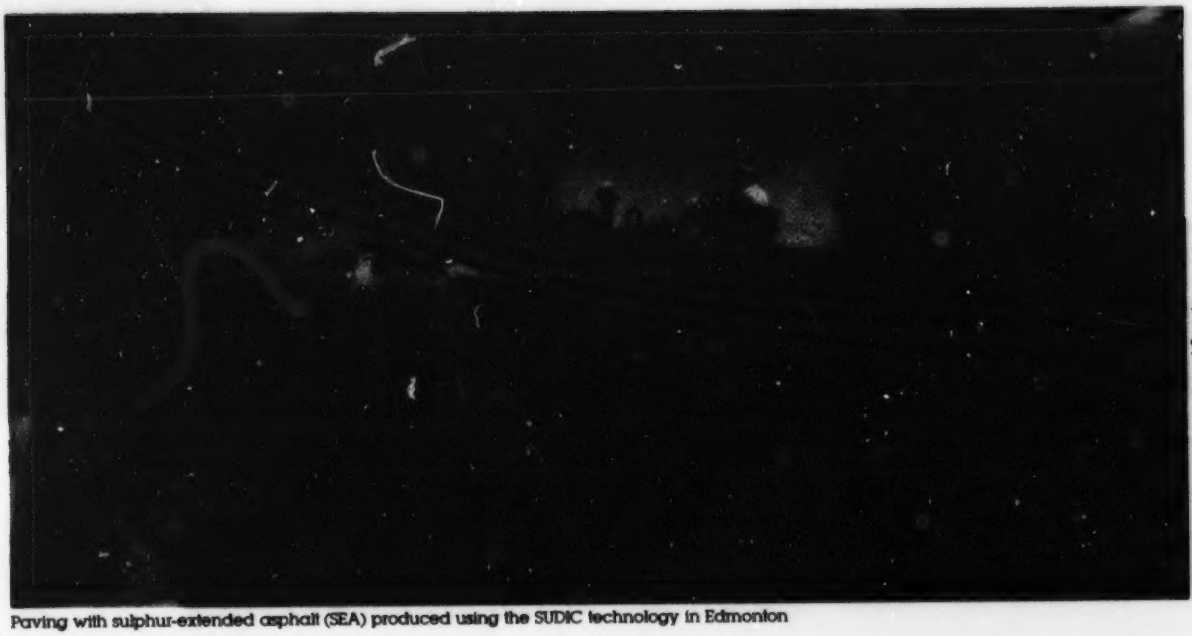


Photo: Sulphur Development Institute of Canada

Paving with sulphur-extended asphalt (SEA) produced using the SUDIC technology in Edmonton

## New Paving Mix Using Sulphur

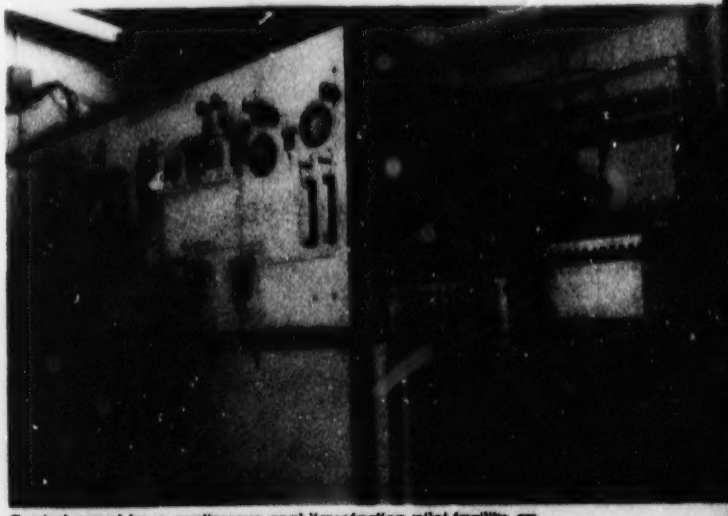
Sulphur Development Institute of Canada (SUDIC), Calgary

Once considered a nuisance, sulphur produced as a byproduct of sour gas has become a valuable resource in Alberta. The Calgary-based Sulphur Development Institute of Canada has played an important role in this change, through development of new commercial uses for sulphur. With A/CERRF support, the Institute completed the development of a new sulphur-extended asphalt mix. The product which resulted from this work and further improvements, has greater strength and performs better in extremes of temperature than conventional asphalt. The new product now accounts for 90 per cent of all commercial sulphur-extended asphalt sold in North America.

## Hydrocarbon Research

Hydrocarbon Research Centre Inc., Edmonton

The Hydrocarbon Research Centre, based at the University of Alberta, offers graduate and post-doctoral students an opportunity to do fundamental energy-related research of direct application to industry. A/CERRF provided funding for the Centre from 1980 to 1984. Of eight projects, four were completed in 1983/84. These included work on the development of chemical flooding processes for the recovery of light oil reserves, the chemical stabilization of petroleum fractions for study by field ionization mass spectrometry, new technology for the anaerobic breakdown of phenols in waste water, and the mathematical modelling of new developments in coal-cleaning equipment.



Control panel for a continuous coal liquefaction pilot facility, an ongoing project supported by the Hydrocarbon Research Centre.

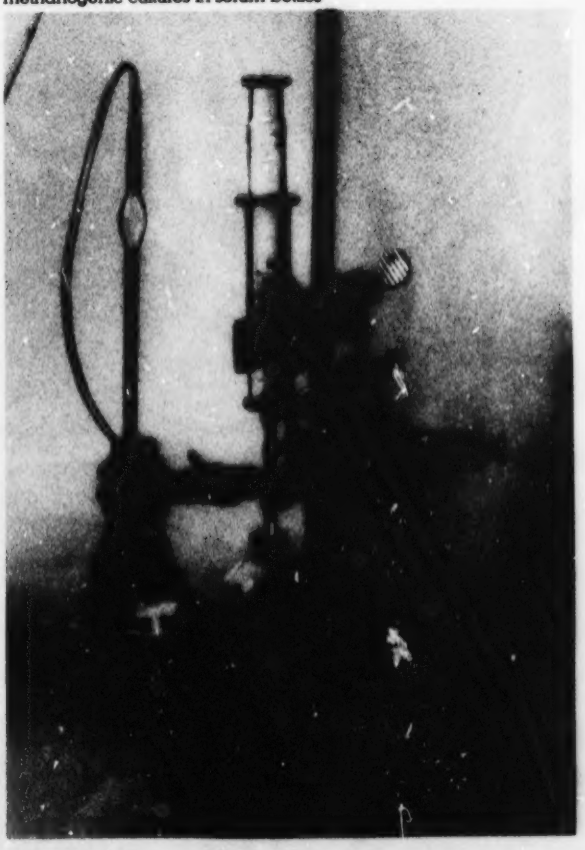
# OTHER CONVENTIONAL ENERGY RESOURCES RESEARCH PROJECTS SUPPORTED BY A/CERRF

## A New Strategy for Treating Phenols in Waste Waters

University of Alberta (S.E. Hrudey), Edmonton

In low concentrations, phenols cause taste and odor problems in water, and, in higher concentrations, they are toxic to aquatic organisms and can be a human health hazard. Most research on biological treatment of phenols in waste water has concentrated on aerobic (oxygen-consuming) techniques, which have a number of disadvantages including energy consumption and sludge disposal. This project explored the use of anaerobic bacteria for decomposition, which should be energy and cost efficient. Using laboratory techniques specially developed for this project, the researchers found that 85 per cent of the phenols in a sample of waste water from a coal conversion plant could be degraded beyond detection.

Apparatus for measuring the volume of gas produced by methanogenic cultures in serum bottles



## Enhanced Recovery of Conventional Crude Oil

Petroleum Recovery Institute, Calgary

## Energy Resources Data System

Energy Resources Conservation Board, Calgary

## A Novel Catalyst for Industrial Claus Process Reactors

University of Alberta (I.G. Dalla Lana), Edmonton/Canadian Gas Processors Research Fund, Calgary

## Superior Polymers for Enhanced Recovery of Crude Oil

Raylo Chemicals Ltd., Edmonton

## Thermal Decomposition of Hydrogen Sulphide into Elemental Hydrogen and Sulphur

University of Calgary (T. Chivers), Calgary

## Stable Isotope Research for More Effective Utilization of Alberta Gas Fields

University of Calgary (H.R. Krouse), Calgary

## An Effective Viscosity Model for Flow in Porous Media

University of Calgary (D.W. Ruth), Calgary

## Investigation of Ground Water Flow and Petroleum Occurrences in Alberta

University of Alberta (J. Toth), Edmonton

## Summer Student Program

Alberta Universities, Research Institutions and Industry

# RESEARCH BUILDINGS



Good research facilities and equipment are required to support successful research and development activities. When A/CERRF was initiated in the mid 1970s, modern research laboratory space in Alberta was limited.

To permit the growth of energy resources research, it was necessary to construct a Calgary area research laboratory oriented to oil and gas research, and an Edmonton area laboratory and pilot plant oriented to coal research. These were seen as important contributions to the research and development infrastructure of the province.

The availability of these facilities has enhanced the quality of energy research in the province and has encouraged greater co-operation among research groups with similar interests, as well as providing a better focus and high visibility for Alberta's commitment to energy research. Since that time additional corporate facilities have been built adjacent to the Energy Resources Research Building in Calgary.

## Energy Resources Research Building, Calgary

Alberta Public Works, Supply and Services, Calgary

Research in the Calgary area on Alberta's conventional energy resources is concentrated in the Energy Resources Research Building in the University of Calgary Research Park.

This building was designed and built to provide office and laboratory space for the principal non-profit research groups doing energy research in the Calgary area. Many of these agencies had their research scattered in different facilities on the University of Calgary campus and elsewhere, and it became obvious that their effectiveness would be enhanced if they could be located in a common building, with facilities specifically designed for energy resources research.

Since its completion in 1979, the building has housed the Petroleum Recovery Institute, the Computer Modelling Group and the Canadian Energy Research Institute. The Petroleum Recovery Institute is the largest tenant, occupying about half the research space.

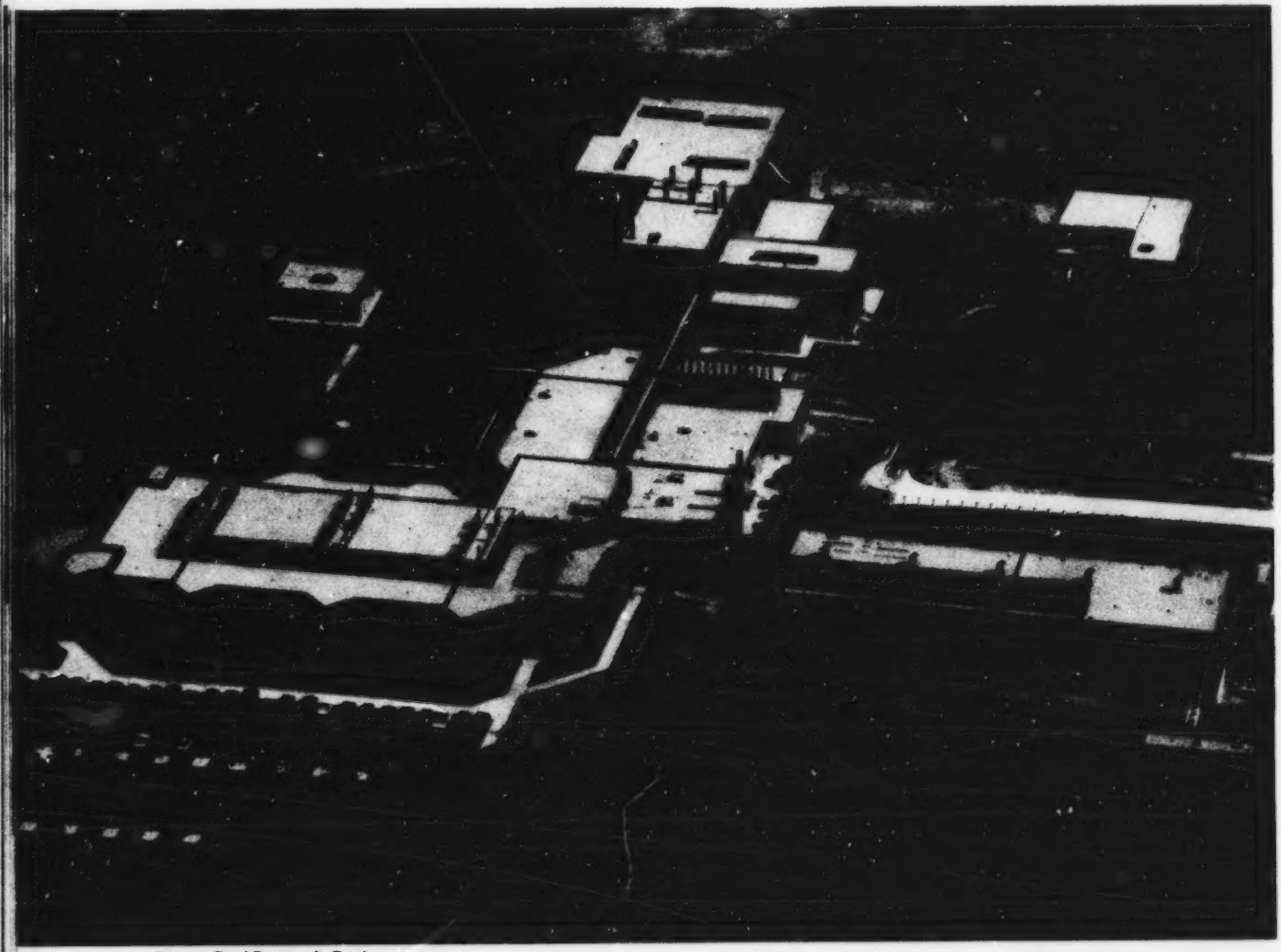
As well as 15 specialized laboratories and associated office work space, the Energy Resources Research Building features the I.N. McKinnon Memorial Library specializing in the energy field.

## Devon Coal Research Centre

Alberta Public Works, Supply and Services, Edmonton

With the scheduled opening of the Devon Coal Research Centre late in 1984, much of the coal-related research which had been scattered throughout the Edmonton region will be located under one roof. An objective in providing capital funds for the building was not only to provide a first-rate facility, but also to

Energy Resources Research Building, Calgary



Devon Coal Research Centre

stimulate excellent research by encouraging researchers in related areas to share ideas and technical resources.

The Coal Department of the Alberta Research Council, the Coal Mining Research Centre and the CANMET laboratories of the federal Department of Energy, Mines and Resources have all begun work in the 16,000-square-metre complex at Devon, near Edmonton.

The centre has three components: a pilot plant, an office/laboratory complex and a high-head laboratory. The pilot plant is an industrial-scale research facility with space for the testing of mining equipment and of coal processing techniques. Within the office/laboratory complex are standard analytic laboratory facilities, offices, library and meeting rooms. In the high-head laboratory, two massive containment cells provide space behind heavy steel walls for research at high temperatures and pressures. Special efforts were taken to ensure the control of coal dust and cross contamination among different parts of the building.

The Devon Coal Research Centre is expected to be fully operational by the end of 1984.

APRIL 1, 1983 TO
MARCH 31, 1984

# EIGHTH ANNUAL REPORT

# ACTIVE PROJECTS

## Coal Projects

### Reflection Seismic Investigation of Western Canadian Coal Fields

University of Calgary (D.L. Lawton), Calgary

This project examined the potential application of a heavy industrial shotgun as an energy source for seismic investigation of coal seams. The technique was found to have application in the plains region at depths between 60 and 200 metres. The complexity of the geology in the mountain and foothills regions limited the technique's application in this area. A final report was prepared.

### Coal Mining, Beneficiation and Health and Safety Research

Coal Mining Research Centre, Devon

The focus for the Coal Mining Research Centre research and development activities is on technology expected to provide an early application within western Canada's coal industry. Specifically it is to enhance the quality of the coals and reduce the cost of production. Activities during 1983/84 included research related to geophysical exploration, ground control, reclamation, coal drying and upgrading, as well as health and safety. At the end of the fiscal year, the Coal Mining Research Centre was completing its move into the new Devon Coal Research Centre.

### Support Design for Underground Cavities in Weak Rock

University of Alberta (P.K. Kaiser, N.R. Morgenstern), Edmonton

The failure mechanisms of underground openings in weak rock formations, such as those often associated with coal deposits, are not well understood. Results of this three-year laboratory study indicate that under pressure, the size of cavities drilled into block samples of coal change with time. The rate at which these changes occur can be correlated with the probability of failure and the need for modifications to the support structure. The detailed results and implications for mine design are documented in a final report.

### Stability in Underground Coal Pillars

University of Alberta (D.M. Cruden), Edmonton

It is known that coal pillars left in place to support the roof of an underground coal mine gradually weaken with time through the mechanism of creep failure. The project is directed toward increasing the knowledge of this failure mechanism and the ability to predict the rate at which it occurs. Coal samples were tested in the laboratory under varying loads and dimensional changes were monitored. The results are being used to develop a computer model which simulates the failure of the coal specimens. Initial results are promising.

### Beneficiation of Low Rank Alberta Coals by Agglomeration in Pipelines

University of Alberta (C.M. Rodkiewicz, M.L. Jeremic), Edmonton, and Alberta Research Council, Edmonton

This project was the initial research on the beneficiation and agglomeration in pipelines of Alberta coals. The research was completed in 1983/84 and the final report is available.

### Agglomeration of Low Rank Alberta Thermal Coals

Alberta Research Council, Edmonton

Alberta has an abundance of both low rank coal and low grade petroleum (bitumen and heavy oil). When pulverized coal is combined with an emulsion of bitumen or heavy oil and water, the coal is both agglomerated and upgraded. This can be accomplished in either stirred tanks or pipelines. Experiments were dedicated to determine the effects of relative coal and oil concentrations and composition on the quality of the agglomerates. Different techniques for recovering the oil from the agglomerates were studied and a final technical report is being prepared.

### ENR-ARC Conversion Research Program

Alberta Research Council, Edmonton

Funded jointly by A/CERRF and the Alberta Research Council, this program examines the technical potential of different processes for producing liquid fuels from Alberta plains coals. Autoclave testing of nine different subbituminous coals was completed using conditions representative of different liquefaction processes to determine those process conditions most suitable for the different coals. The results indicated a significant difference among coals from the two major outcrops. The emphasis on the program is now shifting to continuous bench scale testing of selected coals and processes.

### Coal Slurry Pipeline Research

Pembina Resources Ltd., Calgary

The viscosity and hydraulic pumping characteristics of four different coal water slurries were determined in small scale pipeline loops. The test results are being used for the conceptual design of commercial scale pipelines for various coal transport applications and to determine their relative economics.

### Coal Technology Information Centre

Alberta Research Council, Edmonton

The Coal Technology Information Centre collects and distributes information on coal mining, beneficiation and utilization. In 1983/84, its holdings included 14,700 items and the staff responded to an average of 384 information requests per month from within the Alberta Research Council, industry, universities and government.

## Energy Conservation and Renewable Energy Projects

### Energy Conservation in Sour Gas Processing

Bow Valley Research, Calgary

In an earlier phase of this project, researchers found energy consumption varied greatly among sour gas plants. During 1983/84, progress was made toward developing a strategy and procedure for identifying areas of potential energy conservation in particular gas plants. Field testing and analysis of accumulated data were used to refine an energy audit process.

### Research on Alberta's Geothermal Energy Resource

University of Alberta (F.W. Jones), Edmonton

Existing underground temperature information from oil and gas exploration was used to prepare a comprehensive analysis of the geothermal energy resources of the province. In 1983/84, the research focused on an anomaly in the Hinton/Edson area, where temperatures close to the surface were much hotter than expected. Possible uses for this energy source were explored.

### Laser Fusion Energy Research

University of Alberta (A.A. Offenberger), Edmonton

A significant advance in the development of nuclear fusion energy technology has been the refinement of high energy laser technology by researchers at the University of Alberta. Results of this project, which was completed early in 1984, may have a number of other promising applications of the developed laser technology, in such fields as medicine, chemistry and electronic component manufacturing. Further work is planned through a joint venture between the University of Alberta and private sector investors.

### Alberta Home Heating Research Facility

University of Alberta (J.D. Dale), Edmonton

On the University of Alberta Farm at Ellerslie, six scaled-down replicas of single-family homes are used for research on energy conservation for residential buildings. Each of these models incorporates different construction features with energy conservation implications. Early research was directed at isolating energy losses and gains from such features as insulation, window placement and air infiltration. Later research, some of which is on-going, has included evaluations of higher-efficiency furnaces and the seasonal performance of masonry and conventional construction.

### Energy Efficient Housing Display Program

Housing and Urban Development Association of Canada (HUDAC), Alberta Chapter, Edmonton

Through the co-operation of HUDAC and builders in Edmonton and Calgary, five energy efficient houses were constructed in each city to demonstrate and monitor residential energy conservation features. The houses were open to the public, with explanatory displays on the conservation measures used. Subsequently, the houses' energy consumption and conservation performance is being monitored.

### Construction and Testing of a Masonry Module

Alberta Masonry Institute, Edmonton, and I-XL Industries Ltd., Edmonton/Medicine Hat

The Alberta Masonry Institute and I-XL Industries have completed the design, construction and testing of an energy efficient load-bearing masonry wall system for residential construction. A test module using a double-thickness masonry wall containing foamed-in-place polyurethane insulation was compared to a conventional wood frame test module. The two were identical except for the wall construction. The masonry module required 75 per cent of the heating energy used for the frame module, and was 20 per cent more airtight. The masonry wall was found to retain heat much longer than the conventional wall. Cost comparisons indicate that higher initial costs could be recovered in energy savings, and lower maintenance costs.

### Energy Conservation in Public Swimming Pools

IBI Group, Calgary

The researchers have undertaken a comprehensive analysis and retrofit feasibility study of City of Calgary swimming pools, aiming at a demonstration of such measures as the control of humidity levels and

upgrading of insulation. The review of the design, energy conservation and operational practices of the 12 City of Calgary public pools has been completed. Several low cost or no cost retrofit measures have been identified, as well as a more comprehensive strategy developed for a representative facility.

### Demonstration of a Cost-Effective Energy Management System

Whitaco Holdings Ltd., Edmonton

A cost-effective energy management system is being tested for controlling the energy consumption in small and medium-sized commercial buildings. The demonstration of this system is expected to have great potential for commercialization of the product and related technology.

### Development of a User Friendly Computerized Building Management System

MLW Interspace Management Ltd., Edmonton

An easy-to-use and inexpensive microprocessor-based building energy management system is being developed for small and medium-sized buildings. The system includes a remote programmable controller and a monitoring and control system. The remote controller is designed to be linked over the telephone to the monitoring and control station, so that a number of different buildings could be controlled by one centre. Such a system could monitor and control energy use in such facilities as schools, swimming pools or stores.

### A New Heat-Conserving Control System for Warehouse-Type Buildings

Camcon Controls Ltd., Calgary

Camcon Controls Ltd. is developing a complete control strategy for warehouse unit heaters. The project includes field testing of the new controllers, which switch off the heaters in warehouses when their overhead doors are open. If substantial energy savings are demonstrated, this development could lead to the establishment of a company manufacturing the system in Alberta.

### Computer Simulations for Mechanical Systems in Buildings

Southern Alberta Institute of Technology, Calgary

The Power Engineering Department of SAIT is developing computer simulations to assist in training personnel in the operation of heating and ventilation systems. The simulation training will lead operators and trainees to an understanding of system operations, as well as the development of energy conservation control techniques. A specialized computer system is being designed and built and the required software is being developed.

### Self-Help Retrofit Manual for Owners of Multi-Family Housing Units

Alternative and Retrofit Energies Ltd., Calgary

Owners and operators of housing co-operatives, condominiums, row housing, townhouses, public housing and other forms of multi-family housing often face a bewildering range of options in attempting to retrofit such buildings for energy conservation. Alternative and Retrofit Energies Ltd. is preparing a step-by-step guide to help operators in making decisions about energy savings and retrofitting. Research is underway to test some heat loss analysis and retrofitting techniques.

### Development of Higher Efficiency Gas-Fired Furnaces

Flame-Master, Division of Bow Valley Industries, Edmonton

Flame-Master is developing a line of higher efficiency gas-fired furnaces and suspended unit heaters which will be manufactured in Alberta. It is expected that, as well as creating manufacturing jobs, the availability of a successful line of Alberta-built higher efficiency products will encourage their use, with resulting energy and cost savings.

### Multi-Zone Setback Thermostat

Daxcom Electronics Inc., Calgary

The development has begun of a cost-effective "smart thermostat" capable of controlling up to 16 heating zones and/or variable volume ventilation and air conditioning systems.

### Sizing of Warm Air Furnances for Residential Use

J.E. Sworder Engineering Ltd., Edmonton

Today's more energy efficient houses have increased the need for warm air furnaces to provide the necessary volume of air circulation, as well as heating. This project was designed to illustrate these changing requirements, by calculating heating and air circulation needs under different operating conditions and insulation standards. Most of the data analysis and calculations have been completed.

### Energy Savings and Payback of Retrofit Basement Wall Insulations

Dow Chemical Canada Inc., Edmonton/Toronto

Basement heat losses account for a large portion of the energy costs in poorly insulated homes. This

demonstration project is designed to calculate both the actual heat loss and the cost of thermal upgrading for existing homes. During 1983/84, basement insulation was installed on two occupied houses, with monitoring to be conducted during the 1984/85 heating season.

### Retrofit Wall Systems for Residential Housing

Alternative and Retrofit Energies Inc., Calgary

One of the better approaches to older houses with poor air sealing and wall insulation is the construction of an additional insulating wall on the exterior of the existing building. A detailed survey of existing retrofit wall systems is underway, and a field demonstration of a preferred wall system is being planned.

### Townhouse Retrofit Demonstration

Love Energy Consultants, Calgary

Many residential energy conservation measures can be implemented by a home handyman. Using non-luxury townhouses, this project was designed to demonstrate dollar and energy savings possible for townhouses through such measures. Initial field testing showed that for the measures considered, the payback periods would be long, as the costs of significant improvements were found to be higher than expected.

### A Ventilation Control System Based on Carbon Dioxide Levels

Cheriton Engineering Ltd., Calgary

Conventional mechanical ventilation systems provide a fixed amount of outdoor air, based on the maximum number of occupants for which the building is designed. This project will test and evaluate an alternative approach, a control system responsive to carbon dioxide levels. A carbon dioxide sensing and control system would automatically vary the outdoor air with occupant load, resulting in savings due to the reduced heating and cooling of fresh air supplied to the building. A pre-design analysis has been completed.

### A Survey of Air Leakage in Alberta Homes

Bill Johnston Architect Ltd., Calgary

A representative cross-section of owner-occupied housing is being studied to provide information on the energy costs resulting from air leakage. An assessment will be made of the effectiveness and cost of different techniques for sealing homes against uncontrolled air leakage. Testing of up to 120 homes for infiltration and exfiltration rates has begun and monitoring of gas consumption for heating the sample houses is underway.

### Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta

Vinto Engineering Ltd., Edmonton

More than 100 computer programs for building design and analysis were reviewed to prepare an inventory of programs useful to Albertans. Preparation of a comprehensive Alberta input data base incorporating weather and climate information from eight areas of the province was initiated. The weather data base is to be used with detailed energy analysis programs to allow building designers to prepare energy efficient and cost effective designs for use anywhere in Alberta.

### Development of an Insulating Curtain for Residential Installation

Sunergy Systems Ltd., Carstairs

The objective of this project is the development of an insulating curtain for residential use which will provide increased comfort as well as energy savings. Major hardware components and manufacturing techniques have been selected and field testing of initial prototypes has begun.

### Energy Efficient Fluorescent Lighting Ballast

Comtrac Industries Ltd., Calgary

There is potential for a reduction in energy consumption for fluorescent lighting by 30 to 50 per cent through the design of an electronic fluorescent lighting ballast. As well as the energy saved on lighting, there would be further savings on air-conditioning costs in warm weather, as the new system would give off much less heat. A detailed literature survey and review of the state-of-the-art is being completed and the identification of required component parameters has started.

### Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology

EMC Energy Management Consultants Ltd., Calgary

A new air-to-air heat exchanger for residential use based on heat pipe technology shows good potential for energy efficiency and cost effectiveness. A survey of existing technology has been completed, and a heat pipe heat exchanger has been designed. Manufacture and testing of prototypes will be undertaken during 1984/85.

### Concrete Masonry Walls for Thermal Storage, Heating and Insulation

Centre for Research and Development in Masonry, Calgary

Most residential building in Alberta is of frame construction. Rising energy costs have made other approaches cost effective because of improved energy conserving characteristics and performance. The heat storage and insulation properties of masonry construction, for example, could make it an attractive alternative. Work has started on a detailed literature review of current knowledge on the thermal properties of masonry elements and buildings.

### Solar and Wind Energy Research

Alberta Research Council, Edmonton

The Solar and Wind Energy Research Program consists of the Solar and Wind Energy Information Centre and Data Base and a Solar and Wind Energy Monitoring Program, using sophisticated instrumentation at strategic locations throughout the province.

The information centre and computer data base now includes nearly 10,000 technical articles and publications accessible to the private sector, governments and the general public. The monitoring program continued the gathering and processing of data on wind and solar energy from its seven stations throughout the province. Such data are useful to designers, builders, utilities, wind turbine manufacturers and distributors, environmental researchers and others.

### A Large Delta-Blade Wind Turbine, An Alberta Development

Abax Energy Services Ltd./Deltx Windpump Corporation, Calgary

A new direct water pumping wind turbine with a 16-metre diameter rotor on a 31.4-metre tower has been developed. A prototype turbine was built and erected in Calgary, and is being tested. The low-cost high-efficiency turbine is now being commercialized and has attracted considerable interest internationally.

### Demonstration and Testing of Small-Scale Wind Turbines

Alberta Agriculture, Lethbridge

Six different types of wind turbines were installed at Alberta Agriculture's test site near Lethbridge during 1983/84, and monitored to assess their economic and technical potential for a number of water pumping applications. A progress report has been completed and is available.

## Conventional Energy Resources Projects

### Enhanced Recovery of Conventional Crude Oil

Petroleum Recovery Institute, Calgary

Using conventional recovery methods, the petroleum industry can seldom recover more than 30 per cent of the oil in a reservoir. The Petroleum Recovery Institute is investigating techniques which could lead to recovery of an additional 300 to 475 million cubic metres of oil from existing reserves. Work includes testing of gases and chemicals for injection into underground formations within the development of enhanced recovery of crude oil techniques. Most of the Institute's funding now comes from other sources, but during 1983/84, A/CERRF funds were used to design, construct and test sophisticated equipment for the Institute's Calgary laboratories.

### A Novel Catalyst for Industrial Claus Process Reactors

University of Alberta (I.G. Dalla Lana), Edmonton/Canadian Gas Processors Research Fund, Calgary

A new laboratory-developed catalyst was tested in an industrial setting, in a project supported by additional funds from the Canadian Gas Processors' Association and by Gulf Canada Ltd. A pilot plant on the site of Gulf's Nevis sour gas plant was used to test and compare the new catalyst's performance in the Claus Process reactor. This process uses controlled burning and catalysts to convert hydrogen sulphide to liquid elemental sulphur and other byproducts. The results indicate that the new catalyst has some improved characteristics compared to conventional catalysts, including greater durability, thus allowing extended plant operating periods.

### Hydrocarbon Research

Hydrocarbon Research Centre Inc., Edmonton

The Hydrocarbon Research Centre conducts fundamental studies on Alberta fossil fuel resources. The work is directed at improving the understanding of the resources and the techniques to recover them, and also provides technically-trained manpower for continuing work.

During 1983/84, the research concentrated on eight projects in the areas of:

- coal-cleaning technology;
- light oil recovery;

- the chemical components of heavy oil and bitumen;
- testing of catalysts for upgrading coal liquids;
- treatment of waste water from synthetic fuel plants;
- production of superior liquid fuels from coal;
- development of improved technology for natural gas treatment; and
- development of new chemical methods of sulphur and nitrogen removal from liquid fossil fuels.

### Investigation of Ground Water Flow and Petroleum Occurrences in Alberta

University of Alberta (J. Toth), Edmonton

The hydrogeologic approach to petroleum exploration is based on the theory that petroleum is transported by ground water. This on-going study involves basic research to evaluate this theory by determining ground water flow and checking if known hydrocarbon accumulations are found in predictable areas. If the results support this theory, geologists will have a valuable tool for predicting the location of petroleum reserves. The data has been compiled for the Taber test region, and evaluation of the information is underway.

### A New Strategy for Treating Phenols in Waste Waters

University of Alberta (S.E. Hrudey), Edmonton

Using an apparatus developed especially for the project, the use of anaerobic bacteria to decompose phenols contained in waste water was explored. Anaerobic decomposition offers a number of potential advantages, including energy and cost efficiency. The project was successfully concluded in 1983/84, and is attracting considerable commercial interest.

### Summer Student Program

Alberta Universities, Research Institutions and Industry

During the summer of 1983, A/CERRF helped universities, technical institutes, industry and research organizations create summer jobs for 71 engineering and physical sciences students by providing salary contributions for research projects in areas related to their academic work.

## Research Buildings

### Devon Coal Research Centre

Alberta Housing and Public Works, Supply and Services, Edmonton

Completion of this world-class facility for coal research in the Edmonton area is expected by the end of 1984. In 1983/84, construction of an office/laboratory complex as well as a pilot plant for coal cleaning and upgrading were completed. Construction of the high-head laboratory and site development were well underway by the end of the fiscal year.

# FINANCIAL STATEMENT

As part of the November 1976 agreement between the Prime Minister of Canada and the Premier of Alberta to fund energy resources research, $96 million has been transferred to the province.

The transferred funds are deposited to the General Revenue Account of the Alberta Treasury and are subsequently made available to projects approved by the Alberta/Canada Energy Resource Research Fund Committee.

From April 1, 1983 to March 31, 1984 the amounts shown in the following table were transferred to, and expended by, the projects listed. Funding by year for all approved projects to date is shown in Tables 1 to 5 of Appendix B.

Total program expenditures from the beginning of the program in 1976 until March 31, 1984 were $60,544,977.

## SUMMARY OF TRANSFERS TO AND EXPENDITURES BY APPROVED PROJECTS FROM APRIL 1, 1983 TO MARCH 31, 1984

| Project | Balance Brought Forward From 1982/83 | Transferred[1] | Expended[2] | Balance[3] |
|---|---|---|---|---|
| Reflection Seismic Investigation of Western Canadian Coal Fields | 546 | 3,018 | 3,564 | - |
| Coal Mining, Beneficiation and Health and Safety Research | 131,358 | 1,146,352 | 1,194,065 | 83,645 |
| Support Design for Underground Cavities in Weak Rock | (10,615) | 11,965 | 1,350 | - |
| Stability of Underground Coal Pillars | - | 15,095 | 14,439 | 656 |
| Coal Ash Monitoring System | (6,941)[4] | 6,941 | - | - |
| Beneficiation of Alberta Coals by Agglomeration in Pipelines | (2,575) | 24,795 | 22,220 | - |
| Agglomeration of Low Rank Alberta Thermal Coals | - | 123,079 | 136,754 | (13,675) |
| ENR-ARC Coal Conversion Research Program | (1,743,591) | 4,746,428 | 3,034,865 | (32,028) |
| Coal Slurry Pipeline Research | - | 103,413 | 114,903 | (11,490) |
| Coal Technology Information Centre | - | 114,830 | 114,830 | - |
| Ice Nucleation Technique for Defouling Heat Exchangers | (7,171)[4] | 7,171 | - | - |
| Efficient Use of Low Heating Value Fuels | (5,563)[4] | 5,563 | - | - |
| Energy Conservation in Sour Gas Processing | - | 93,637 | 93,637 | - |

| Project | Balance Brought Forward From 1982/83 | Transferred[1] | Expended[2] | Balance[3] |
|---|---|---|---|---|
| | | (CONTINUED) | | |
| An Advanced Control Approach for Solar Heating Systems | 540[9] | - | - | 540 |
| Research on Alberta's Geothermal Energy Resource | 48,879 | 8,681 | 57,560 | - |
| Laser Fusion Energy Research | (53,037) | 186,643 | 148,035 | (14,699) |
| Alberta Home Heating Research Facility | (25,151) | 25,417 | 266 | - |
| Energy Efficient Housing Display Program | 9,054 | - | 7,384 | 1,670 |
| Construction and Testing of a Masonry Module | - | 8,938 | 9,931 | (993) |
| Energy Conservation in Public Swimming Pools | - | 8,972 | 9,969 | (997) |
| Demonstration of a Cost-Effective Energy Management System | - | 7,584 | 8,427 | (843) |
| Development of a User Friendly Computerized Building Management System | - | 4,435 | 4,928 | (493) |
| A New Heat-Conserving Control System for Warehouse-Type Buildings | - | 3,184 | 3,538 | (354) |
| Computer Simulations for Mechanical Systems in Buildings | - | 7,997 | 8,886 | (889) |
| Self-Help Retrofit Manual for Owners of Multi-Family Housing Units | - | 1,570 | 1,744 | (174) |
| Development of Higher Efficiency Gas-Fired Furnaces | - | 3,938 | 4,376 | (438) |
| Multi-Zone Setback Thermostat | - | 7,523 | 8,359 | (836) |
| Sizing of Warm Air Furnaces for Residential Use | - | 2,873 | 3,192 | (319) |
| Energy Savings and Payback of Retrofit Basement Wall Insulation | - | 456 | 506 | (50) |
| Retrofit Wall Systems for Residential Housing | - | 308 | 342 | (34) |
| Townhouse Retrofit Demonstration | - | 5,829 | 6,477 | (648) |
| A Ventilation Control System Based on Carbon Dioxide Levels | - | 544 | 604 | (60) |
| A Survey of Air Leakage in Alberta Homes | - | 14,138 | 15,709 | (1,571) |
| Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta | - | 1,336 | 1,484 | (148) |
| Development of an Insulating Curtain for Residential Installation | - | 7,243 | 8,047 | (804) |
| Energy Efficient Fluorescent Lighting Ballast | - | 17,608 | 19,565 | (1,957) |
| Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology | - | 848 | 943 | (95) |
| Concrete Masonry Walls for Thermal Storage, Heating and Insulation | - | 5,275 | 5,861 | (586) |
| Solar and Wind Energy Research | 9,860 | 236,144 | 254,195 | (8,191) |
| A Large Delta-Blade Wind Turbine, An Alberta Development | - | 495,289 | 477,772 | 17,517 |
| Demonstration and Testing of Small-Scale Wind Turbines | - | 47,324 | 47,324 | - |

| Project | Balance Brought Forward From 1982/83 | Transferred[1] | Expended[2] | Balance[3] |
|---|---|---|---|---|
| Enhanced Recovery of Conventional Crude Oil | (3,083) | 213,083 | 210,000 | - |
| A Novel Catalyst for Industrial Claus Process Reactors | - | 3,346 | 3,346 | - |
| Hydrocarbon Research | 544,320 | - | 424,207 | 120,113 |
| Stable Isotope Research for More Effective Utilization of Alberta Gas Fields | (6,150) | 6,150 | - | - |
| Investigation of Ground Water Flow and Petroleum Occurrences in Alberta | 29,661 | 65,562 | 55,830 | 39,393 |
| A New Strategy for Treating Phenols in Waste Waters | 1,333 | - | 1,333 | - |
| Summer Student Program | - | 262,322 | 262,322 | - |
| Devon Coal Research Centre | - | 8,623,690 | 8,623,690 | - |
| **Total Projects** | **(1,088,596)** | **16,686,537** | **15,426,779** | **171,162** |
| Administration | - | 216,278 | 216,278 | - |
| **Total A/CERRF** | **(1,088,596)** | **16,902,815** | **15,643,057** | **171,162** |

(1) Funds transferred by the Department of Energy and Natural Resources to contractors for application to projects in accordance with signed agreements.

(2) Project expenditure by contractors funded by ERRF transfers. Interest and other revenue amounting to $26,024 have not been included in (1) and expenditures have been reduced by the same amount.

(3) Balance of ERRF funds remaining with contractors at March 31, 1984.

(4) Transfer of funding holdback following acceptance of final project report.

(5) Outstanding funding balance of previously completed project.

# APPENDIX A

## A/CERRF COMMITTTE MEMBERS 1976-84

| Alberta | Years Served |
|---|---|
| **G.W. Govier,** (Co-Chairman 1976-78), Chief Deputy Minister, Energy and Natural Resources | 1976-78 |
| **J.B. Mellon,** (Co-Chairman 1978-84), Deputy Minister, Energy and Natural Resources | 1976-84 |
| **J.P. Meekison,** Deputy Minister, Federal and Intergovernmental Affairs | 1976-78 |
| **C.W. Bowman,** Chairman, Alberta Oil Sands Technology and Research Authority | 1978-83 |
| **L.G. Hurd,** Executive Director, Scientific and Engineering Services, Energy and Natural Resources | 1978-80 |
| **R.D. McDonald,** Executive Director, Scientific and Engineering Services, Energy and Natural Resources | 1980- |
| **Ian Burn,** Director, Energy Conservation Branch, Energy and Natural Resources | 1984- |

| Canada | |
|---|---|
| **C.H. Smith,** (Co-Chairman 1976-78), Senior Assistant Deputy Minister, Energy, Mines and Resources | 1976-78 |
| **J.D. Keys,** (Co-Chairman 1978-81), Assistant Deputy Minister (Science and Technology), Energy, Mines and Resources | 1976-81 |
| **K. Whitham,** (Co-Chairman 1981-84), Assistant Deputy Minister, Research and Technology, Energy, Mines and Resources | 1981- |
| **P.J. Dyne,** Director General, Office of Energy Research and Development, Energy, Mines and Resources | 1976- |
| **J.H. Walsh,** Senior Advisor, Coal Conservation and Non-Petroleum Energy, Energy, Mines and Resources | 1978-83 |
| **T.D. Brown,** Director, Coal Research Laboratories, CANMET, Energy, Mines and Resources | 1983- |

# APPENDIX B

TABLE 1:

## SUMMARY OF A/CERRF PROGRAM EXPENDITURES BY YEAR

| Subprograms | Fiscal Year 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total |
|---|---|---|---|---|---|---|---|---|
| Coal Projects | 56,592 | 264,972 | 505,521 | 2,147,941 | 4,140,115 | 5,541,932 | 4,636,990 | 17,294,063 |
| Energy Conservation and Renewable Energy Projects | 410,626 | 804,014 | 1,102,615 | 767,801 | 1,252,178 | 864,233 | 1,209,061 | 6,410,528 |
| Conventional Energy Resources Projects | 2,193,826 | 2,489,255 | 2,657,869 | 3,160,684 | 2,770,237 | 1,067,838 | 957,038 | 15,296,747 |
| Research Buildings | 145,810 | 1,936,830 | 1,188,549 | 41,667 | 1,209,486 | 7,579,298 | 8,623,690 | 20,725,330 |
| **Total Programs** | **2,806,854** | **5,495,071** | **5,454,554** | **6,118,093** | **9,372,016** | **15,053,301** | **15,426,779** | **59,726,668** |
| Administration | 40,094 | 102,631 | 70,755 | 102,526 | 121,640 | 164,385 | 216,278 | 818,309 |
| **Total A/CERRF** | **2,846,948** | **5,597,702** | **5,525,309** | **6,220,619** | **9,493,656** | **15,217,686** | **15,643,057** | **60,544,977** |

TABLE 2:

## RESEARCH PROJECTS' EXPENDITURES BY YEAR

### Coal Projects

| Fiscal Year | 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total to Date |
|---|---|---|---|---|---|---|---|---|
| Analysis of the Coal Bearing Strata Near Cadomin, Alberta | - | 507 | 15,762 | 3,731 | - | - | - | 20,000 |
| Reflection Seismic Investigation of Western Canadian Coal Fields | - | - | - | - | 35,668 | 17,760 | 3,564 | 56,992 |
| Coal Mining, Beneficiation and Health and Safety Research | 54,537 | 250,910 | 428,162 | 674,315 | 837,722 | 1,099,318 | 1,194,065 | 4,539,029 |
| Support Design for Underground Cavities in Weak Rock | - | - | - | 28,221 | 54,532 | 48,051 | 1,350 | 132,154 |
| Stability of Underground Coal Pillars | - | - | - | - | - | - | 14,439 | 14,439 |
| Coal Ash Monitoring System | - | 13,555 | 24,185 | 25,130 | 8,763 | - | - | 71,633 |
| Beneficiation of Alberta Coals by Agglomeration in Pipelines | - | - | - | 49,944 | 60,947 | 74,523 | 22,220 | 207,634 |
| Agglomeration of Low Rank Alberta Thermal Coals | - | - | - | - | - | - | 136,754 | 136,754 |
| ENR-ARC Coal Conversion Research Program | 2,055 | - | 37,412 | 1,182,372 | 3,135,406 | 4,158,527 | 3,034,865 | 11,550,637 |
| Coal Liquefaction Study | - | - | - | 151,864 | - | - | - | 151,864 |
| Coal Slurry Pipeline Research | - | - | - | - | - | - | 114,903 | 114,903 |
| Production of Activated Carbon | - | - | - | 32,364 | 7,077 | - | - | 39,441 |
| Coal Technology Information Centre | - | - | - | - | - | 143,753 | 114,830 | 258,583 |
| **TOTAL - Coal Projects** | **56,592** | **264,972** | **505,521** | **2,147,941** | **4,140,115** | **5,541,932** | **4,636,990** | **17,294,063** |

TABLE 3:

# RESEARCH PROJECTS' EXPENDITURES BY YEAR

## Energy Conservation and Renewable Energy Projects

| Fiscal Year | 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total to Date |
|---|---|---|---|---|---|---|---|---|
| General Energy Conservation | | | | | | | | |
| **Control of Energy Losses by Microbial Fouling of Heat Exchangers** | - | 23,768 | 67,628 | 3,399 | - | - | - | 94,795 |
| **Ice Nucleation Technique for Defouling Heat Exchangers** | - | - | - | - | 75,459 | 3,799 | - | 79,258 |
| **Using Thermal Discharges from Power Plants** | - | 9,653 | 5,347 | - | - | - | - | 15,000 |
| **Fuel and Fertilizer Production from Dairy Manure** | - | 6,176 | 17,148 | - | - | - | - | 23,324 |
| **Efficient Use of Low Heating Value Fuels** | - | - | 11,984 | 32,064 | 15,629 | 143 | - | 39,820 |
| **Streamline Device for Transport Trucks** | - | - | 665 | 5,995 | 2,256 | - | - | 8,916 |
| **Energy Conservation in Sour Gas Processing** | 146,923 | 196,535 | 268,323 | 97,256 | 209,532 | 34,963 | 93,637 | 1,047,174 |
| **Energy from Waste Wood (Sawmill Residue)** | 89,094 | 7,917 | 15,844 | 1,646 | - | - | - | 114,501 |
| **Efficiency of Rotary Piston Engine** | - | 9,213 | 2,644 | - | - | - | - | 11,857 |
| **District Heating Study** | - | - | 66,394 | 33,606 | (6,600) | - | - | 93,400 |
| Solar Energy | | | | | | | | |
| **Copper-Oxide Solar Cells** | - | 8,404 | 20,466 | - | - | - | - | 28,870 |
| **An Atlas of Solar Energy for Alberta** | - | - | 23,730 | 17,884 | 3,015 | - | - | 44,629 |
| **Application for Boiling and Condensation Heat Transfer for Flat Solar Collectors in Cold Regions** | - | - | 27,237 | 33,359 | 25,627 | 12,977 | - | 99,200 |
| **An Air-Mediated Solar Heating System with Long Term Storage** | - | - | 15,706 | 26,907 | - | - | - | 42,613 |
| **An Advanced Control Approach for Solar Heating Systems** | - | - | - | - | 10,219 | 3,082 | - | 13,301 |
| Geothermal Energy | | | | | | | | |
| **Research on Alberta's Geothermal Energy Resource** | - | 18,063 | 43,286 | 75,298 | 60,128 | 83,875 | 57,560 | 338,210 |
| Fusion Energy | | | | | | | | |
| **Laser Fusion Energy Research** | - | 5,784 | 56,111 | 122,995 | 144,855 | 152,927 | 148,035 | 630,707 |
| Energy Conservation in Buildings | | | | | | | | |
| **Alberta Home Heating Research Facility** | - | 2,825 | 142,705 | 44,740 | 33,990 | 19,258 | 266 | 243,784 |
| **Insulation Properties of Flat Built-Up Roofs** | - | 19,268 | 6,584 | 13,929 | 8,176 | 7,980 | - | 55,937 |
| **Energy Efficient Housing Display Program** | - | - | - | - | 221,332 | 3,614 | 7,384 | 232,330 |
| **Passive Solar-Heated Community Centre** | - | - | - | 2,050 | 10,120 | 2,000 | - | 14,170 |
| **Energy Efficient Masonry Fireplaces** | - | - | - | - | - | 48,820 | - | 48,820 |
| **Construction and Testing of a Masonry Module** | - | - | - | - | - | - | 9,931 | 9,931 |
| **Energy Conservation in Public Swimming Pools** | - | - | - | - | - | - | 9,969 | 9,969 |
| **Demonstration of a Cost-Effective Energy Management System** | - | - | - | - | - | - | 8,427 | 8,427 |

## Energy Conservation and Renewable Energy Projects (TABLE 3 CONTINUED)

| Fiscal Year | 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total to Date |
|---|---|---|---|---|---|---|---|---|
| **Development of a User Friendly Computerized Building Management System** | - | - | - | - | - | - | 4,928 | 4,928 |
| **A New Heat-Conserving Control System for Warehouse-Type Buildings** | - | - | - | - | - | - | 3,538 | 3,538 |
| **Computer Simulations for Mechanical Systems in Buildings** | - | - | - | - | - | - | 8,886 | 8,886 |
| **Self-Help Retrofit Manual for Owners of Multi-Family Housing Units** | - | - | - | - | - | - | 1,744 | 1,744 |
| **Development of Higher Efficiency Gas-Fired Furnaces** | - | - | - | - | - | - | 4,376 | 4,376 |
| **Multi-Zone Setback Thermostat** | - | - | - | - | - | - | 8,359 | 8,359 |
| **Sizing of Warm Air Furnaces for Residential Use** | - | - | - | - | - | - | 3,192 | 3,192 |
| **Energy Savings and Payback of Retrofit Basement Wall Insulation** | - | - | - | - | - | - | 506 | 506 |
| **Retrofit Wall Systems for Residential Housing** | - | - | - | - | - | - | 342 | 342 |
| **Townhouse Retrofit Demonstration** | - | - | - | - | - | - | 6,477 | 6,477 |
| **A Ventilation Control System Based on Carbon Dioxide Levels** | - | - | - | - | - | - | 604 | 604 |
| **A Survey of Air Leakage in Alberta Homes** | - | - | - | - | - | - | 15,709 | 15,709 |
| **Inventory of Building Design and Analysis Computer Programs and a Weather Input Data Base for Alberta** | - | - | - | - | - | - | 1,484 | 1,484 |
| **Development of an Insulating Curtain for Residential Installation** | - | - | - | - | - | - | 8,047 | 8,047 |
| **Energy Efficient Fluorescent Lighting Ballast** | - | - | - | - | - | - | 19,565 | 19,565 |
| **Residential Air-to-Air Heat Exchanger Using Heat Pipe Technology** | - | - | - | - | - | - | 943 | 943 |
| **Concrete Masonry Walls for Thermal Storage, Heating and Insulation** | - | - | - | - | - | - | 5,861 | 5,861 |
| Wind Energy | | | | | | | | |
| **Solar and Wind Energy Research** | 174,604 | 496,408 | 310,813 | 256,673 | 334,809 | 233,699 | 254,195 | 2,061,201 |
| **A Large Delta-Blade Wind Turbine, An Alberta Development** | - | - | - | - | 92,945 | 170,400 | 477,772 | 741,117 |
| **Comparison of Wind Turbines** | - | - | - | - | 10,686 | 14,310 | - | 24,996 |
| **Demonstration and Testing of Small-Scale Wind Turbines** | - | - | - | - | - | 72,386 | 47,324 | 119,710 |
| **TOTAL - Energy Conservation and Renewable Energy Projects** | **410,626** | **804,014** | **1,102,615** | **767,801** | **1,252,178** | **864,233** | **1,209,061** | **6,410,528** |

TABLE 4:

# RESEARCH PROJECTS' EXPENDITURES BY YEAR

## Conventional Energy Resources Projects

| Fiscal Year | 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total to Date |
|---|---|---|---|---|---|---|---|---|
| Enhanced Recovery of Conventional Crude Oil | 361,017 | 440,052 | 470,000 | 951,892 | 550,000 | 358,083 | 210,000 | 3,341,044 |
| Software for Computer-Assisted Petroleum Exploration | 383,994 | 428,163 | 682,031 | 500,000 | 300,000 | 200,000 | - | 2,494,188 |
| Helium Recovery from Natural Gas | 1,258,464 | 1,004,683 | 474,309 | 287,886 | 163,702 | 110,956 | - | 3,300,000 |
| Energy Resources Data System | 103,874 | 375,744 | 496,496 | 1,203,657 | 1,420,229 | - | - | 3,600,000 |
| A Novel Catalyst for Industrial Claus Process Reactors | - | - | 14,875 | 10,291 | 11,157 | 19,992 | 3,346 | 59,661 |
| Superior Polymers for Enhanced Recovery of Crude Oil | - | - | 3,400 | 148,841 | 34,654 | - | - | 186,895 |
| New Paving Mix Using Sulphur | 86,477 | 28,523 | - | - | - | - | - | 115,000 |
| Hydrocarbon Research | - | 199,990 | 456,814 | 26,196 | 207,384 | 298,296 | 424,207 | 1,612,887 |
| Thermal Decomposition of Hydrogen Sulphide into Elemental Hydrogen and Sulphur | - | - | 27,754 | 22,448 | 9,510 | - | - | 59,712 |
| Stable Isotope Research for More Effective Utilization of Alberta Gas Fields | - | 12,100 | 16,136 | 6,973 | 21,066 | 5,567 | - | 61,842 |
| An Effective Viscosity Model for Flow in Porous Media | - | - | 16,054 | 2,500 | - | - | - | 18,554 |
| Investigation of Ground Water Flow and Petroleum Occurrences in Alberta | - | - | - | - | 17,623 | 61,189 | 55,830 | 134,642 |
| A New Strategy for Treating Phenols in Waste Waters | - | - | - | - | 34,912 | 13,755 | 1,333 | 50,000 |
| Summer Student Program | - | - | - | - | - | - | 262,322 | 262,322 |
| **TOTAL - Conventional Energy Resources Projects** | **2,193,826** | **2,489,255** | **2,657,869** | **3,160,684** | **2,770,237** | **1,067,838** | **957,038** | **15,296,747** |

TABLE 5:

# RESEARCH PROJECTS' EXPENDITURES BY YEAR

## Research Buildings

| Fiscal Year | 1977-78 | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 | 1983-84 | Total to Date |
|---|---|---|---|---|---|---|---|---|
| Energy Resources Research Building, Calgary | 145,810 | 1,808,279 | 1,005,156 | 41,667 | 213,812 | - | - | 3,214,724 |
| Devon Coal Research Centre | - | 128,551 | 183,393 | - | 995,674 | 7,579,298 | 8,623,690 | 17,510,606 |
| **TOTAL - Research Buildings** | **145,810** | **1,936,830** | **1,188,549** | **41,667** | **1,209,486** | **7,579,298** | **8,623,690** | **20,725,330** |

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ENERGY AND
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Energy, Mines and Resources Canada

Énergie, Mines et Ressources Canada